

Computer Science at Oxford

Michael Spivey

Tutor, Oriel College



UNIVERSITY OF
OXFORD

Department of
COMPUTER
SCIENCE

Copyright © 2013 J. M. Spivey

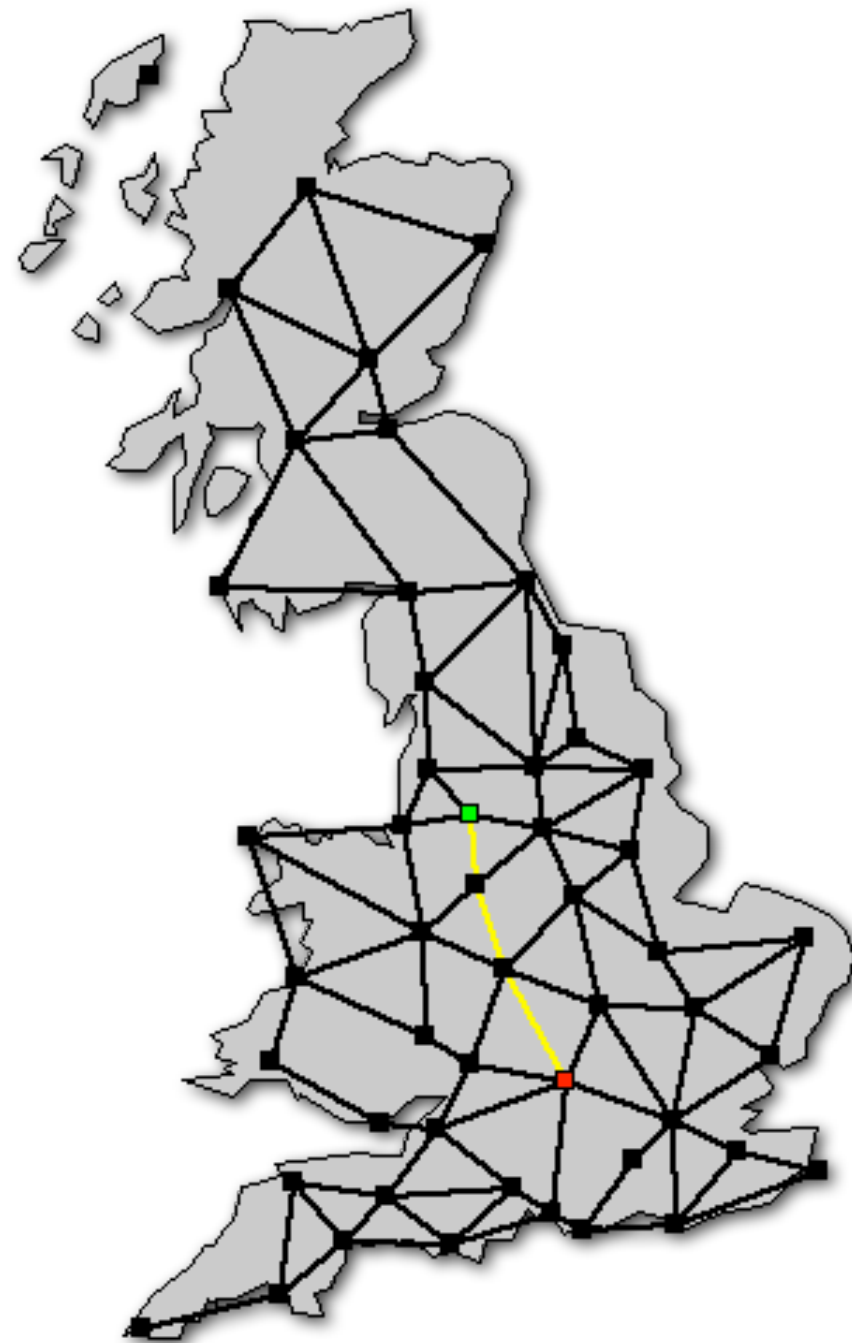
Computer Science at Oxford

- What's Computer Science about?
- The Oxford courses

What's Computer Science about?

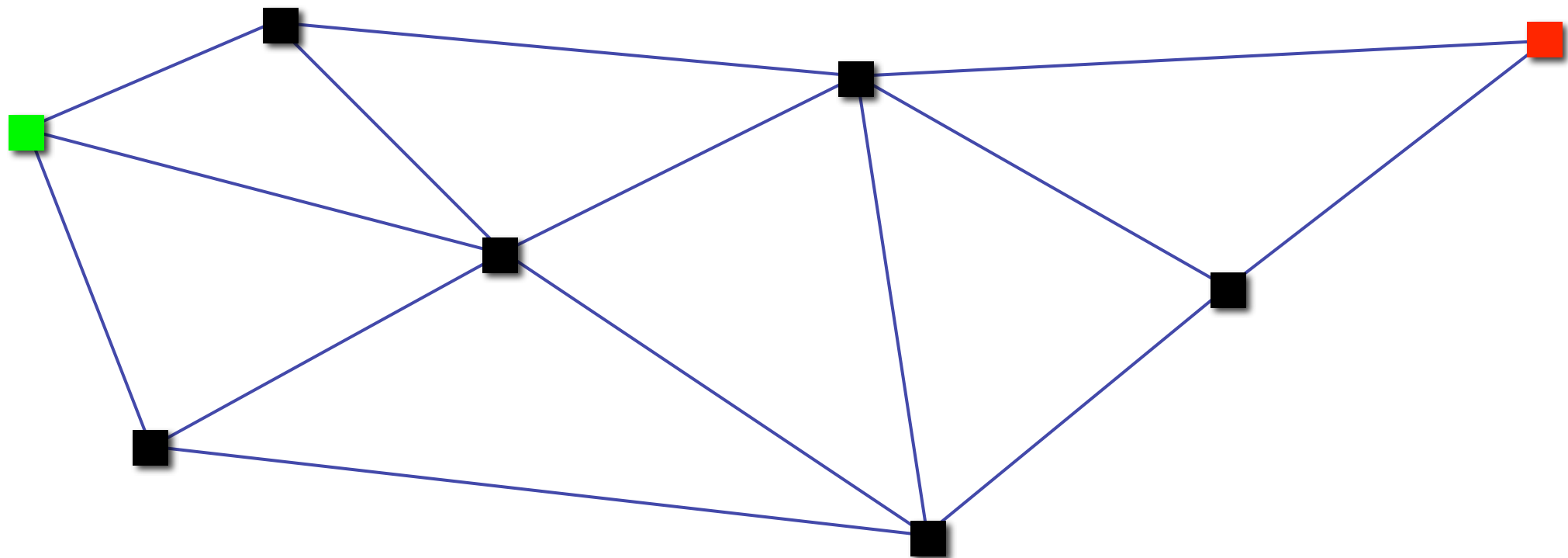
Or, how can you drive
from Manchester to
Oxford?

And how can you get a
computer to show you
the way?



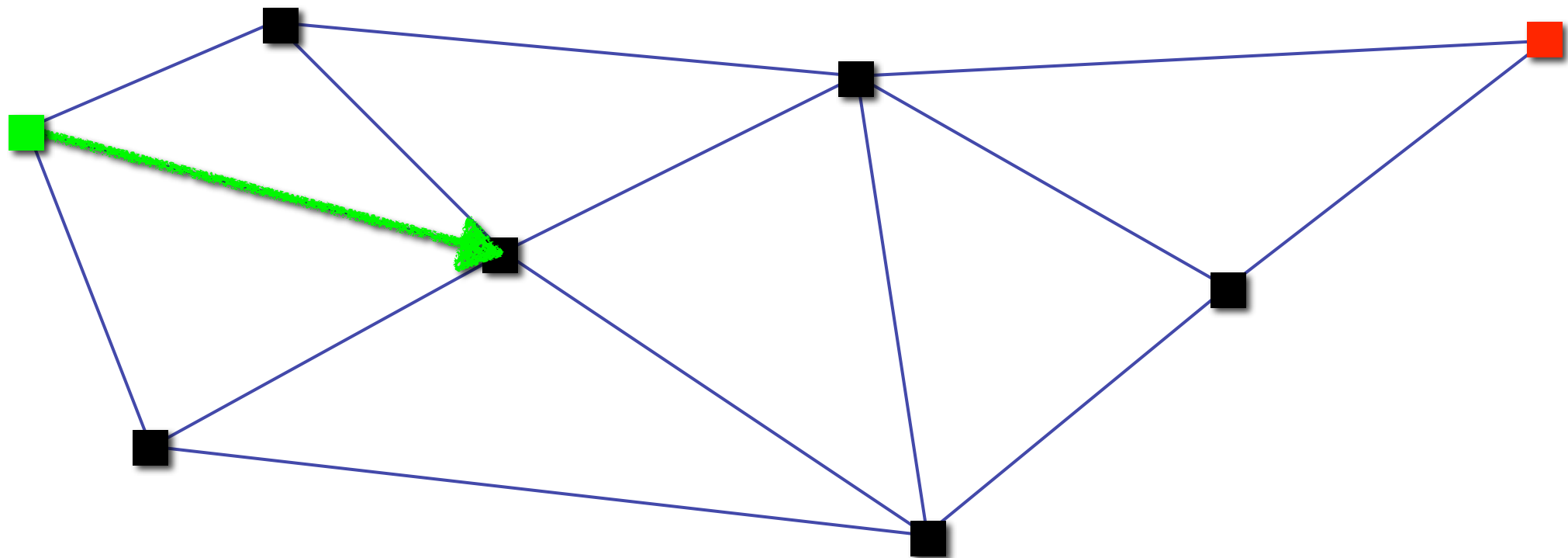
Method A

“Always go in the direction that takes you most directly towards Oxford.”



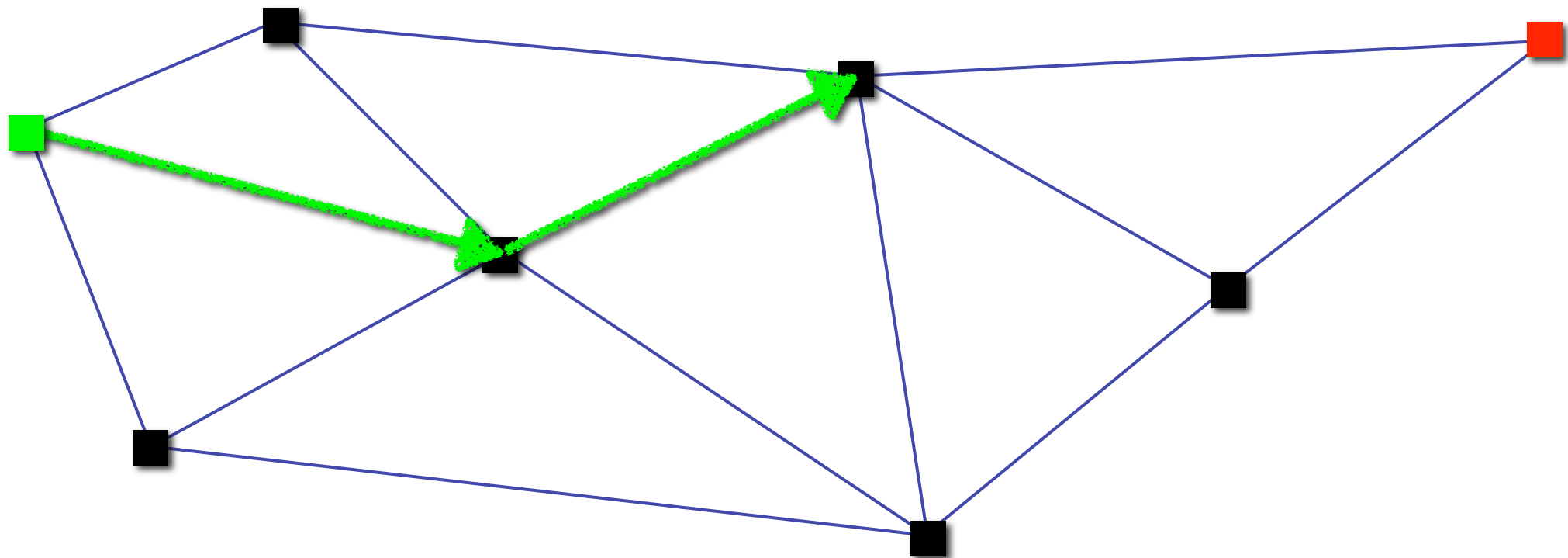
Method A

“Always go in the direction that takes you most directly towards Oxford.”



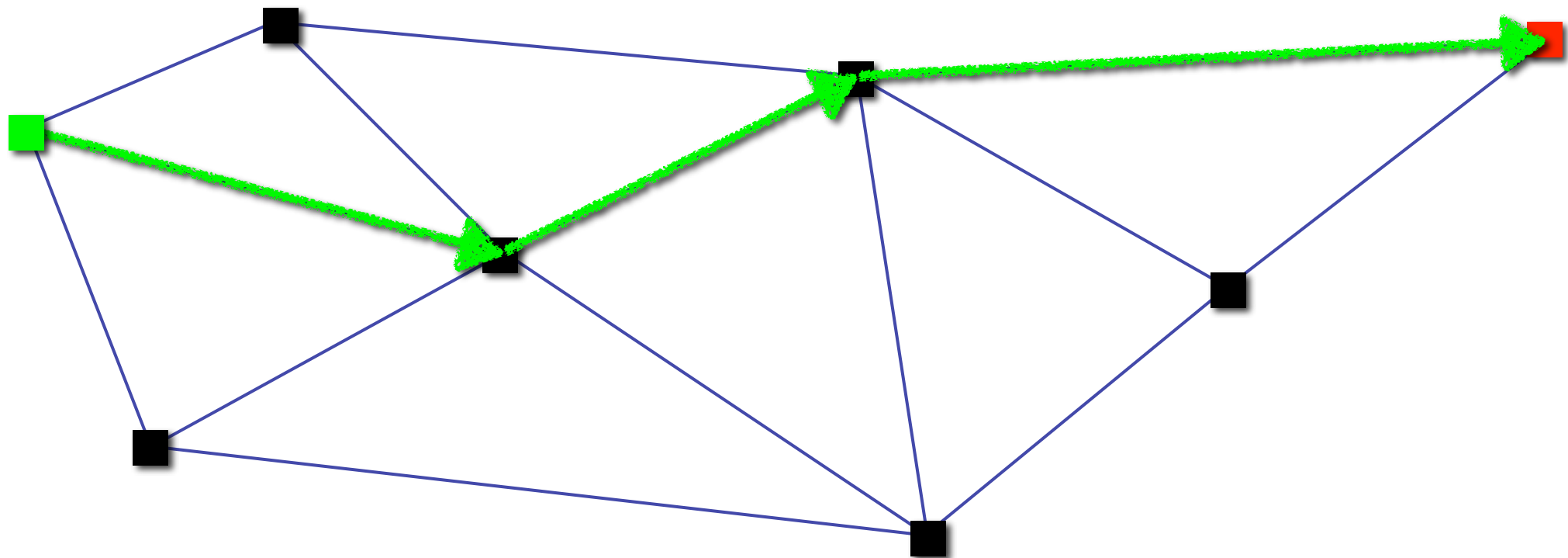
Method A

“Always go in the direction that takes you most directly towards Oxford.”



Method A

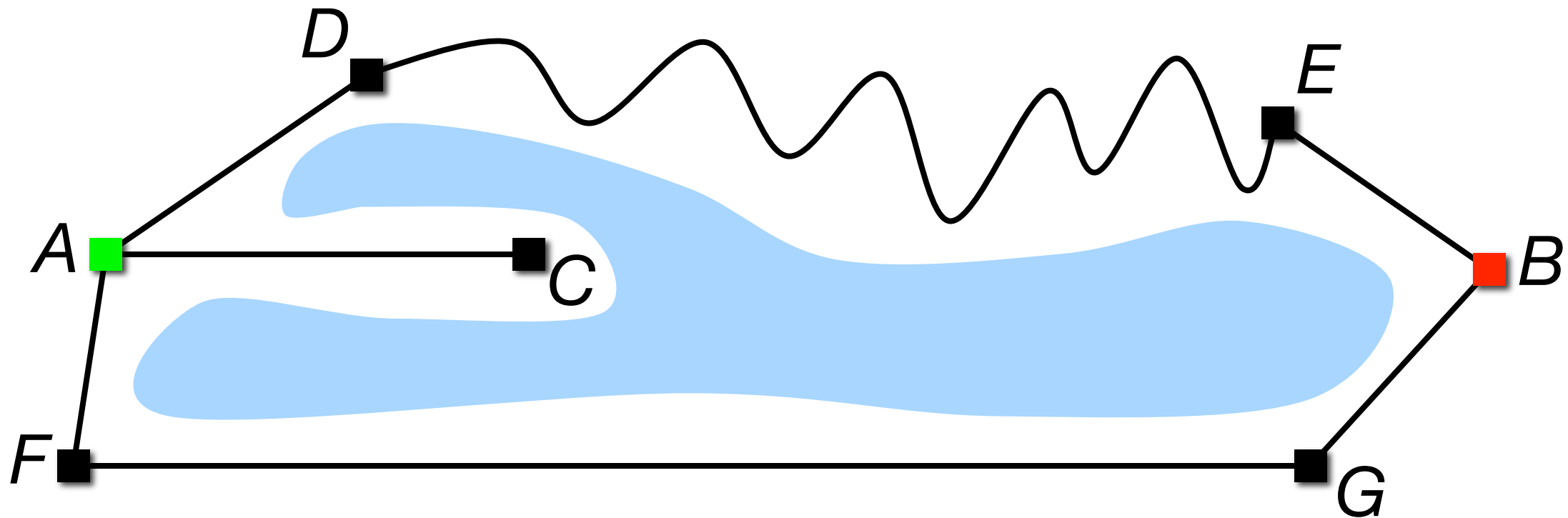
“Always go in the direction that takes you most directly towards Oxford.”



How good is it?

Method A

- *almost always* finds a path from start to finish.
- *sometimes* finds a path that not the shortest.



The programmer's dilemma

Any method that ...

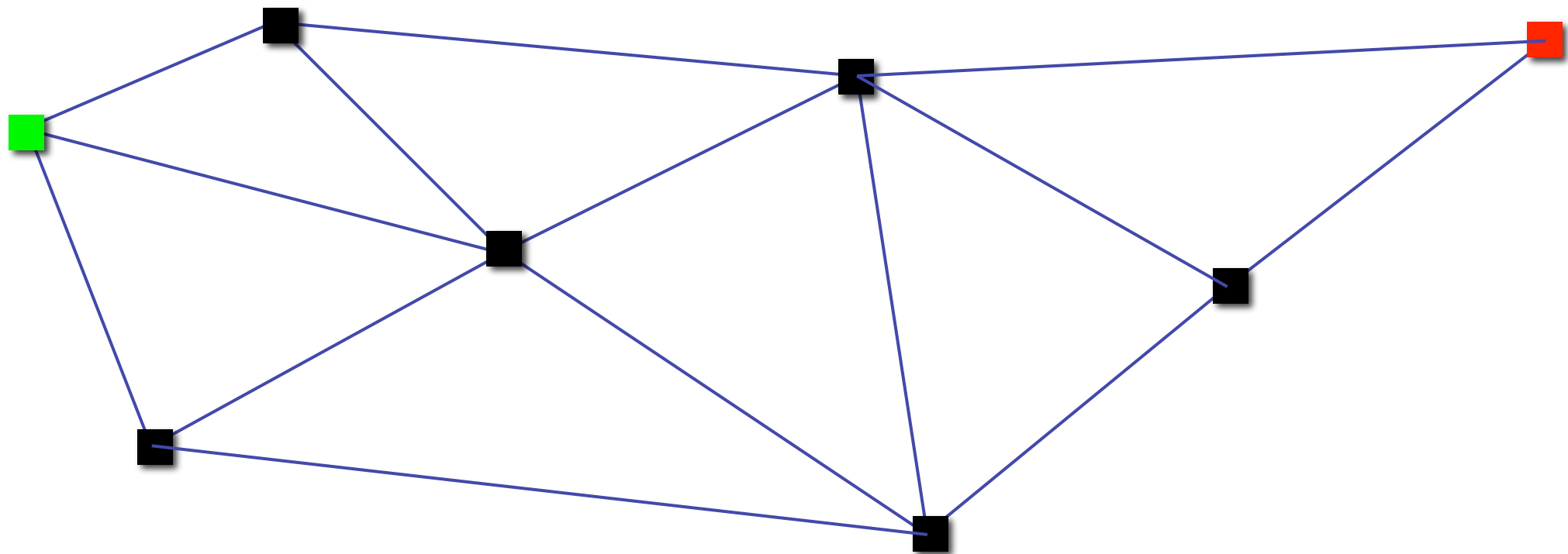
- usually works well but sometimes fails, or
- needs to be used with common sense

... is useless as a computer program.

Method B

Computers are very fast, so

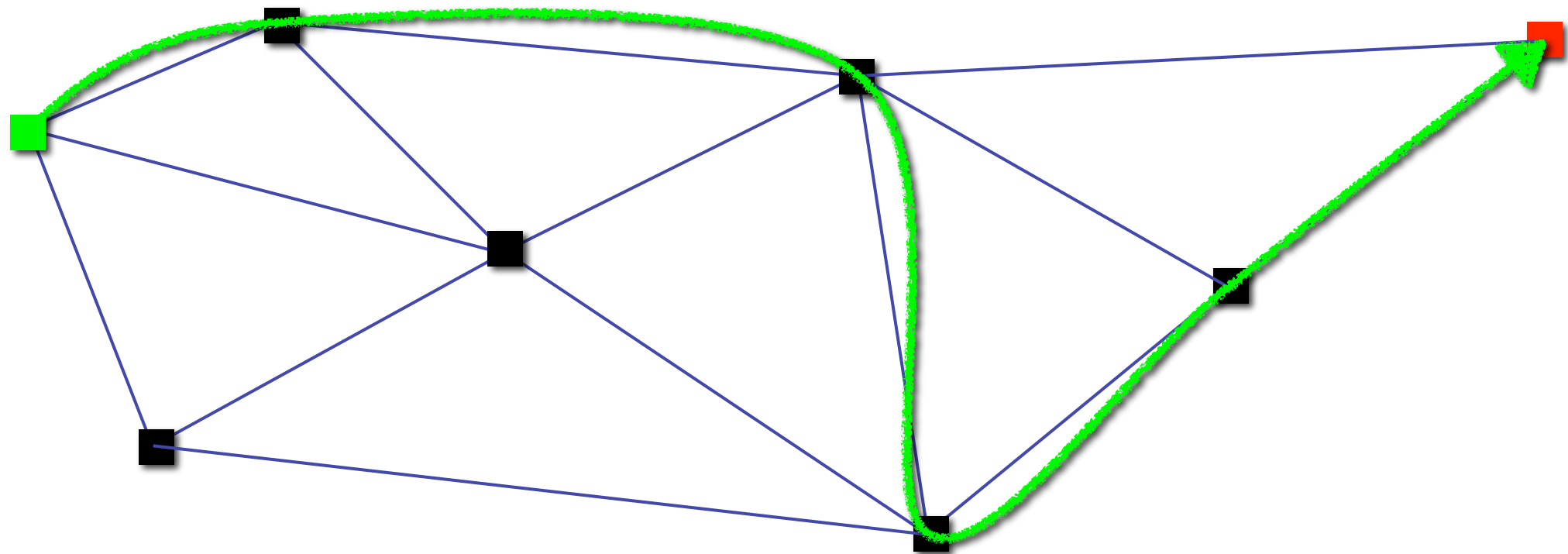
“Consider all routes from Manchester to Oxford, and choose the shortest.”



Method B

Computers are very fast, so

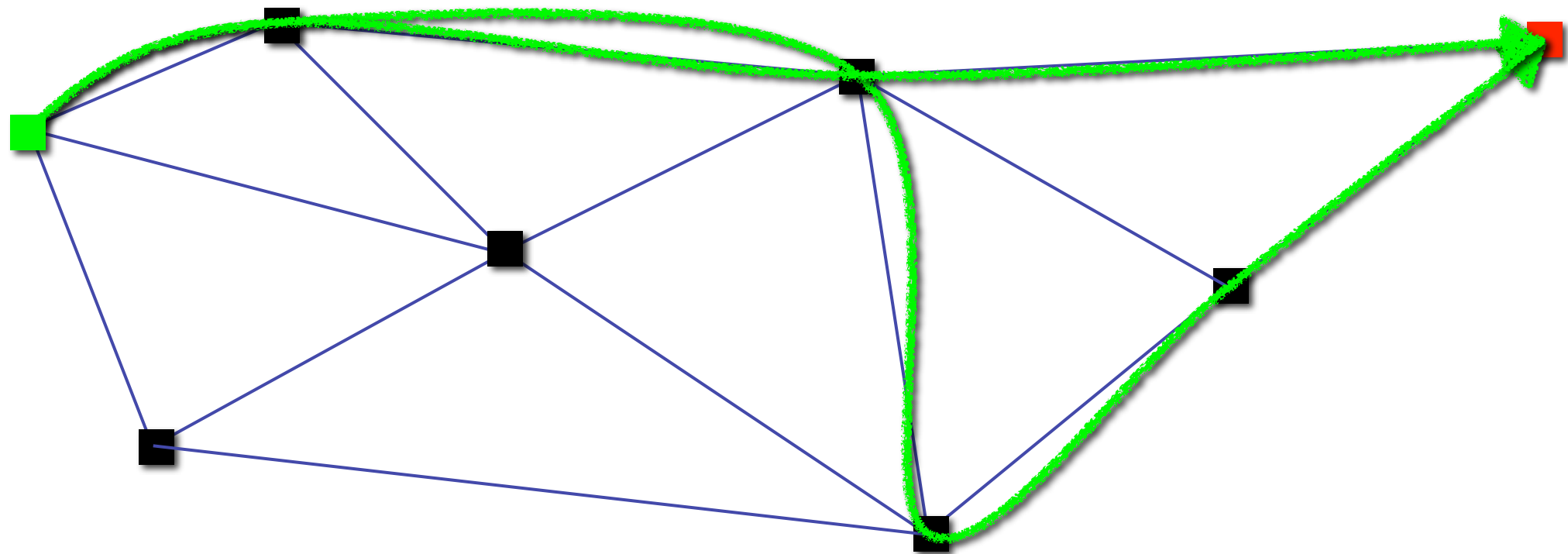
“Consider all routes from Manchester to Oxford, and choose the shortest.”



Method B

Computers are very fast, so

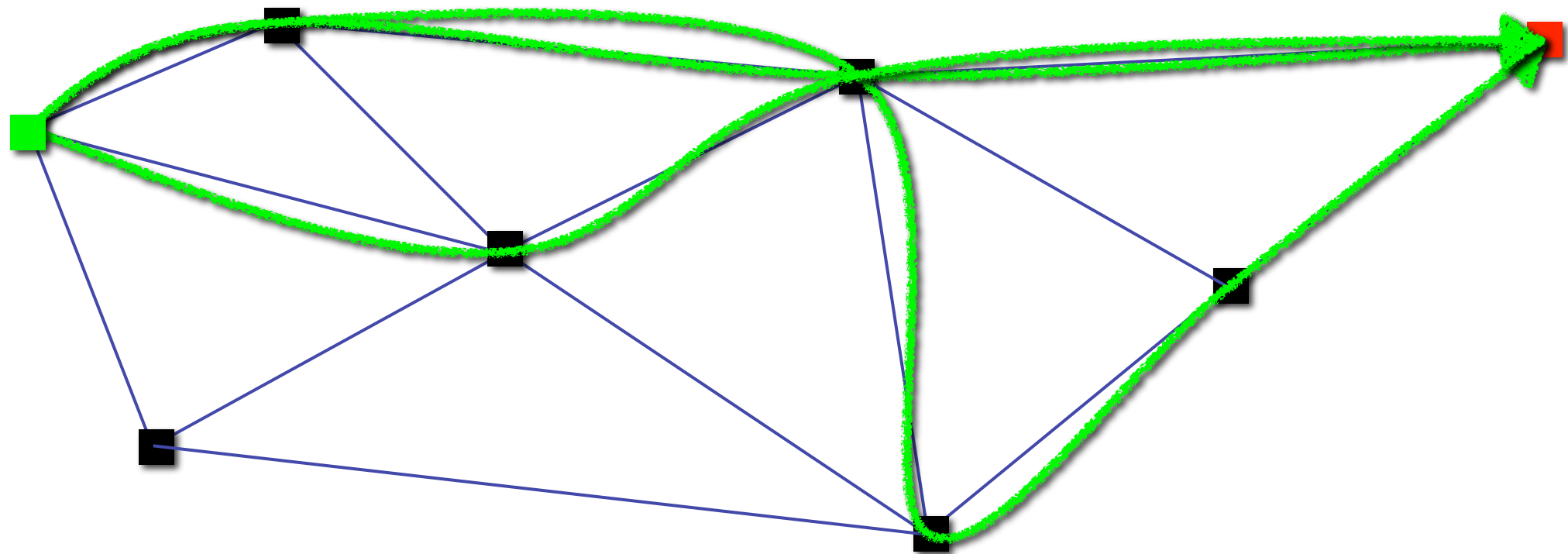
“Consider all routes from Manchester to Oxford, and choose the shortest.”



Method B

Computers are very fast, so

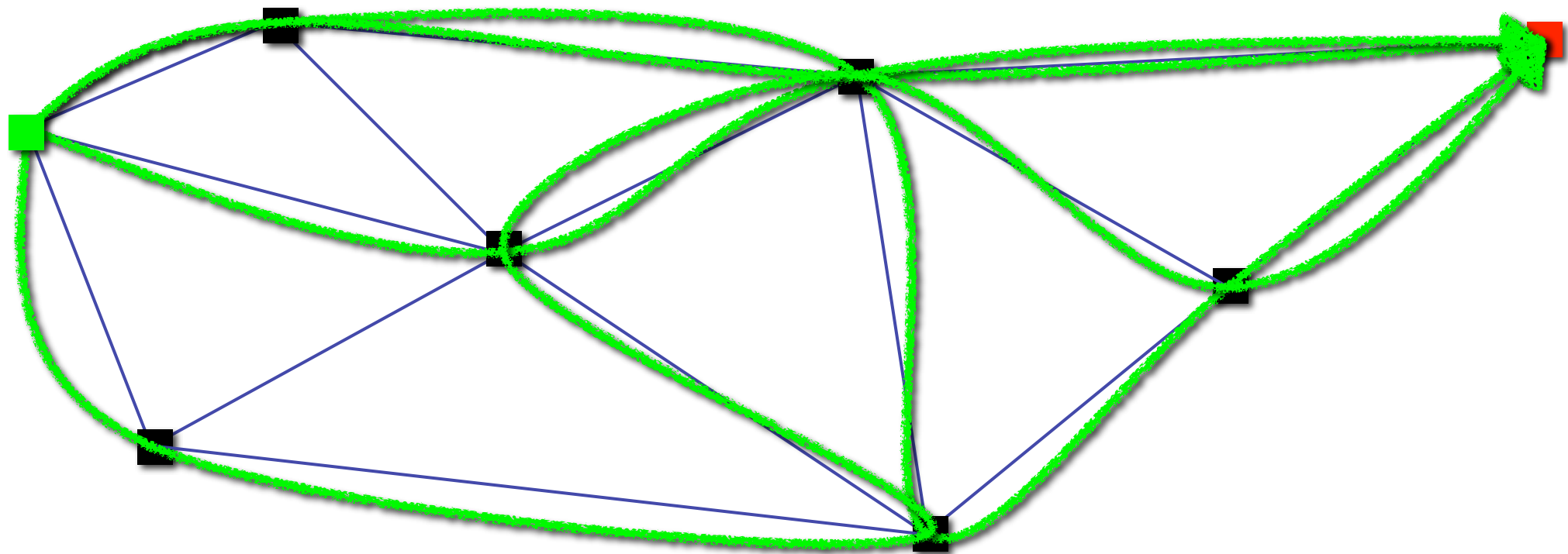
“Consider all routes from Manchester to Oxford, and choose the shortest.”



Method B

Computers are very fast, so

“Consider all routes from Manchester to Oxford, and choose the shortest.”



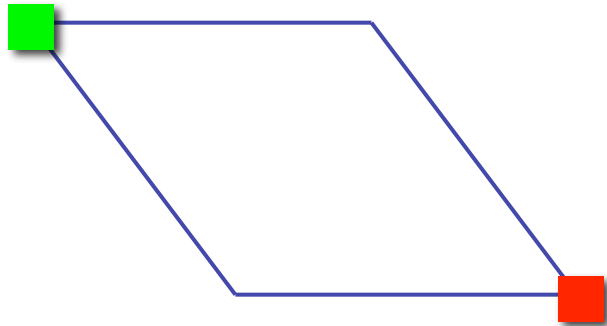
How good is it?

Method B

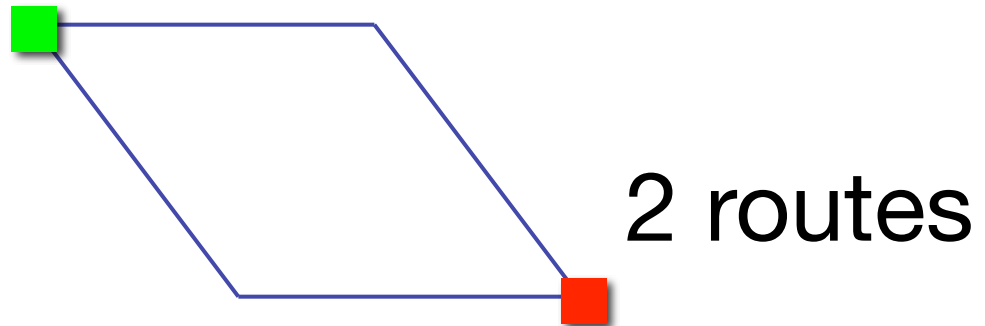
- will certainly find the shortest route.
- but the time taken grows too quickly as the map gets bigger.

How many routes might there be?

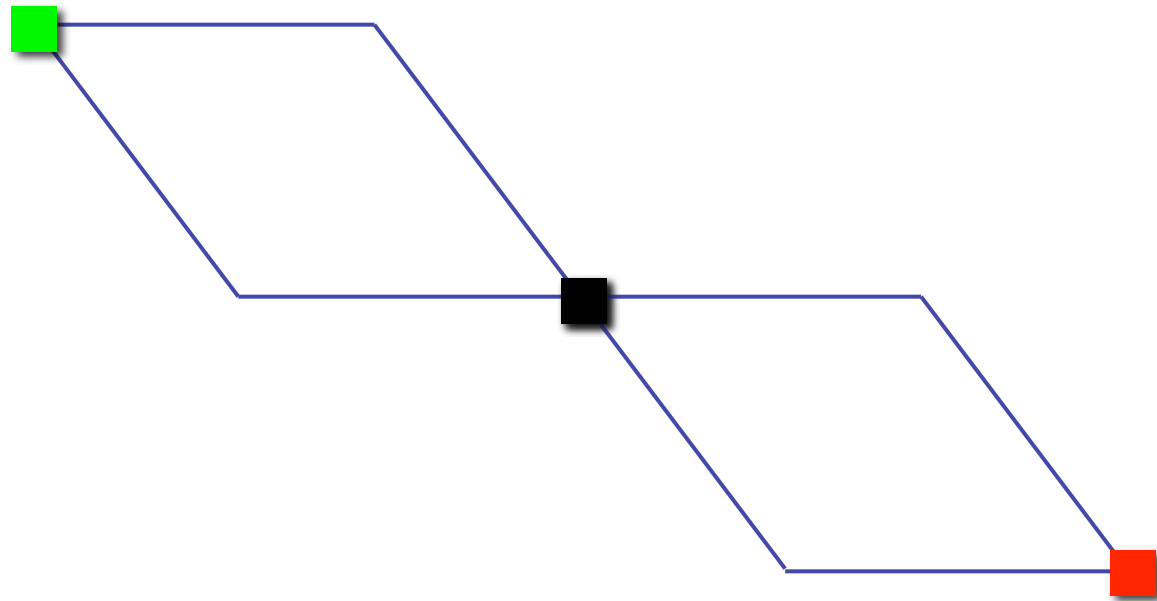
A growing number of routes



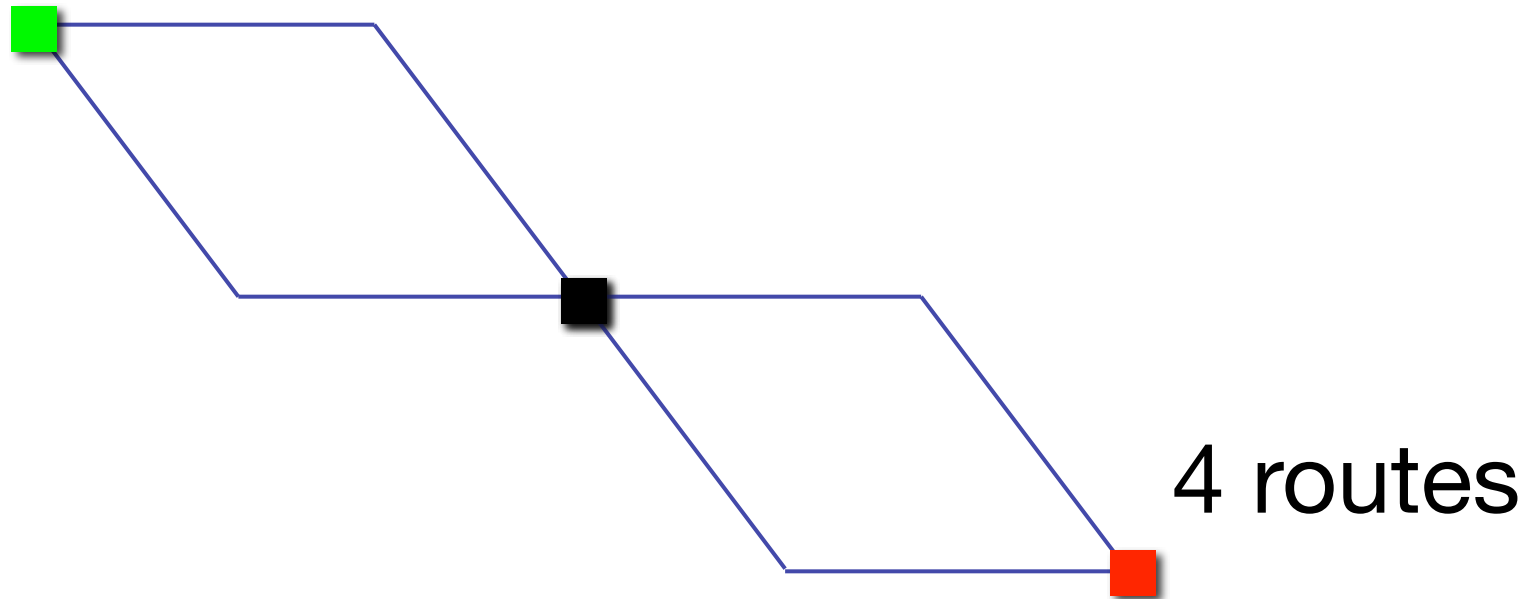
A growing number of routes



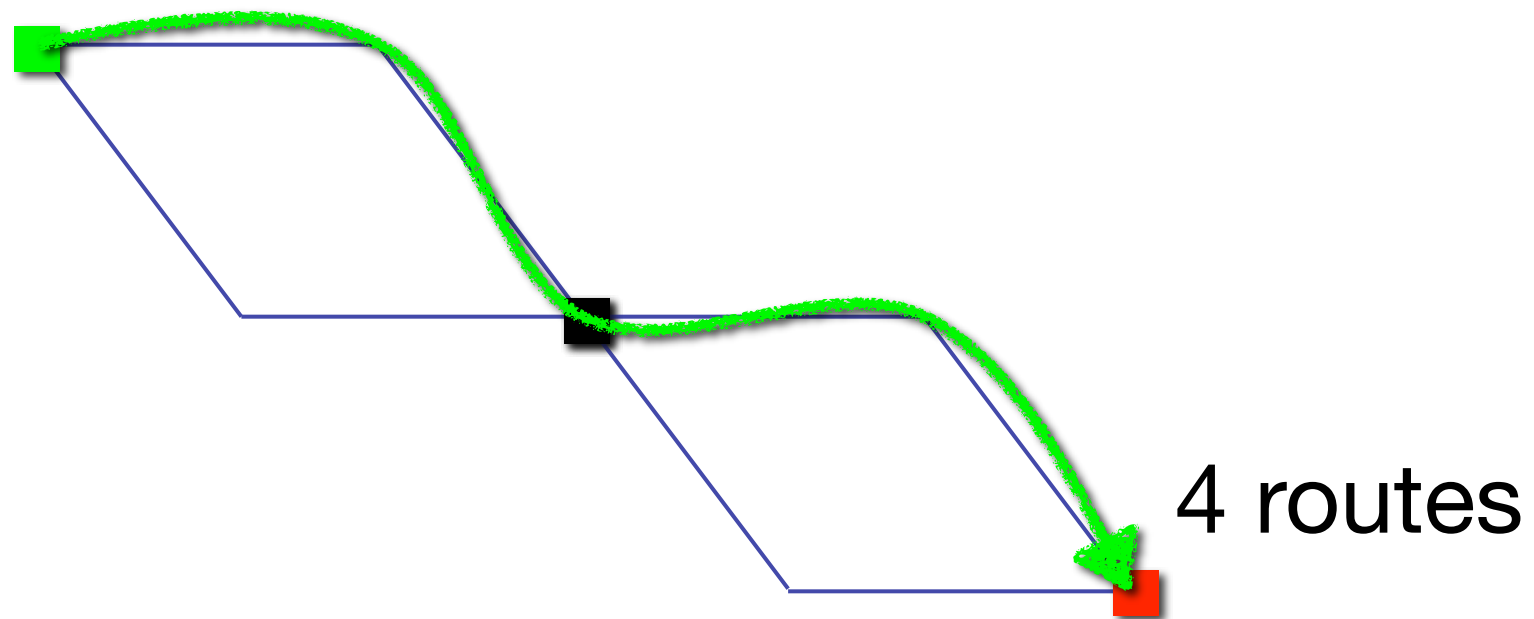
A growing number of routes



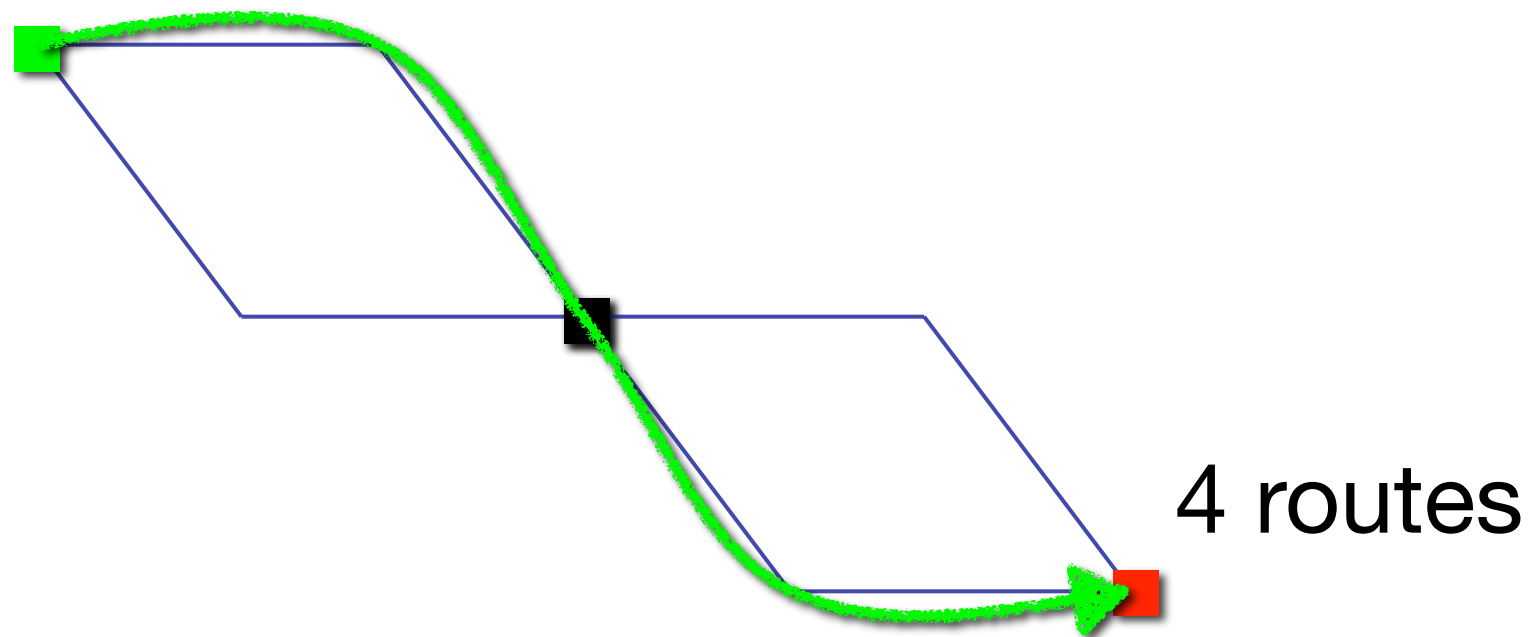
A growing number of routes



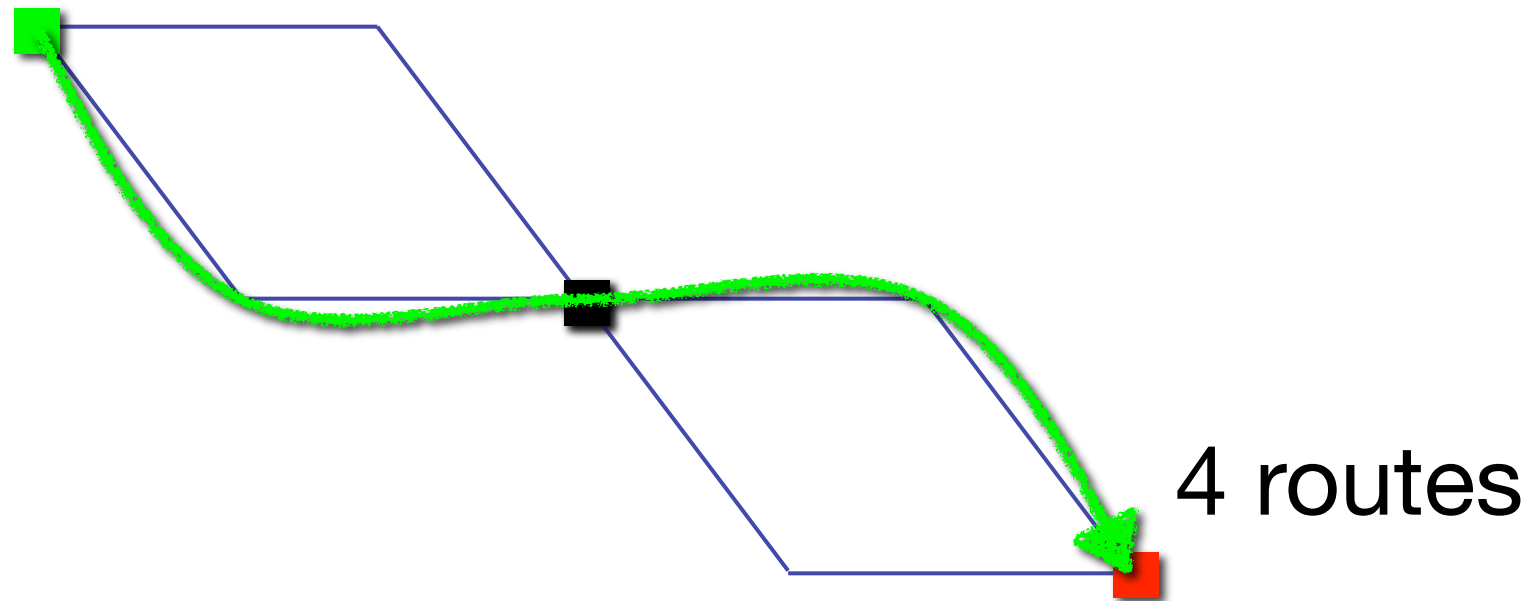
A growing number of routes



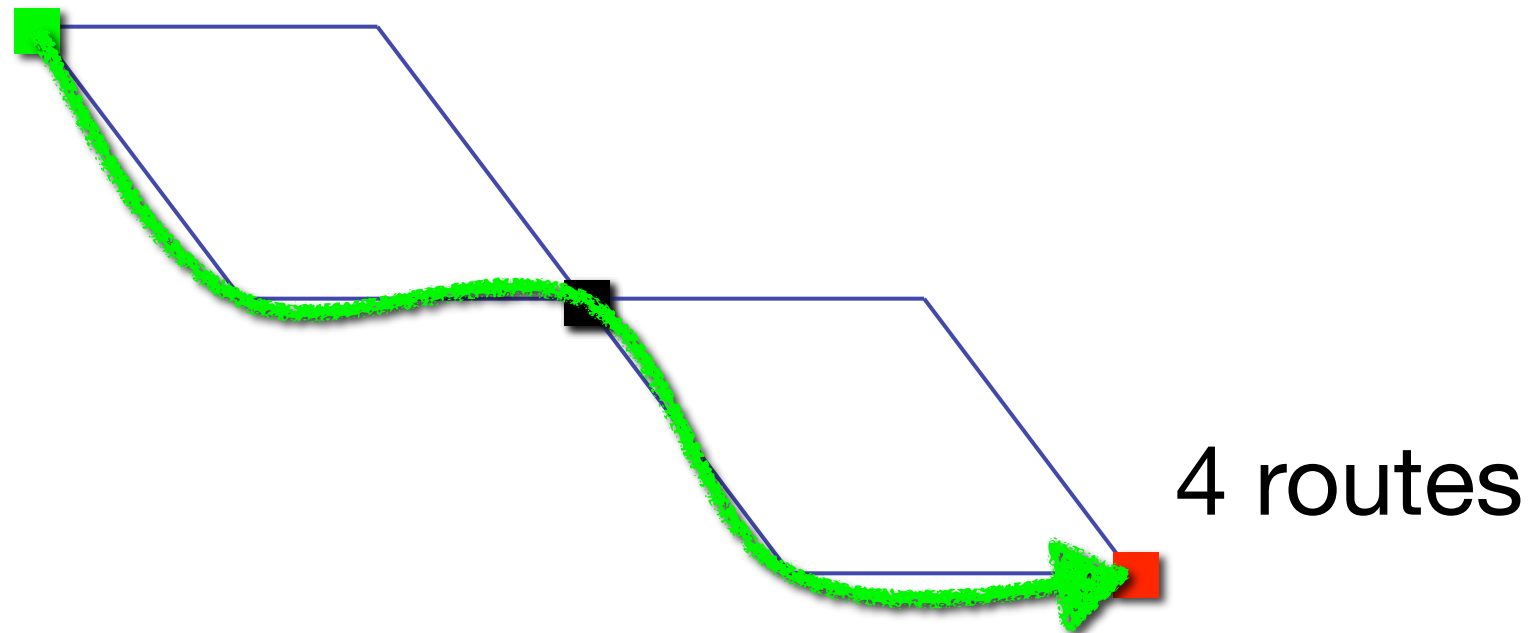
A growing number of routes



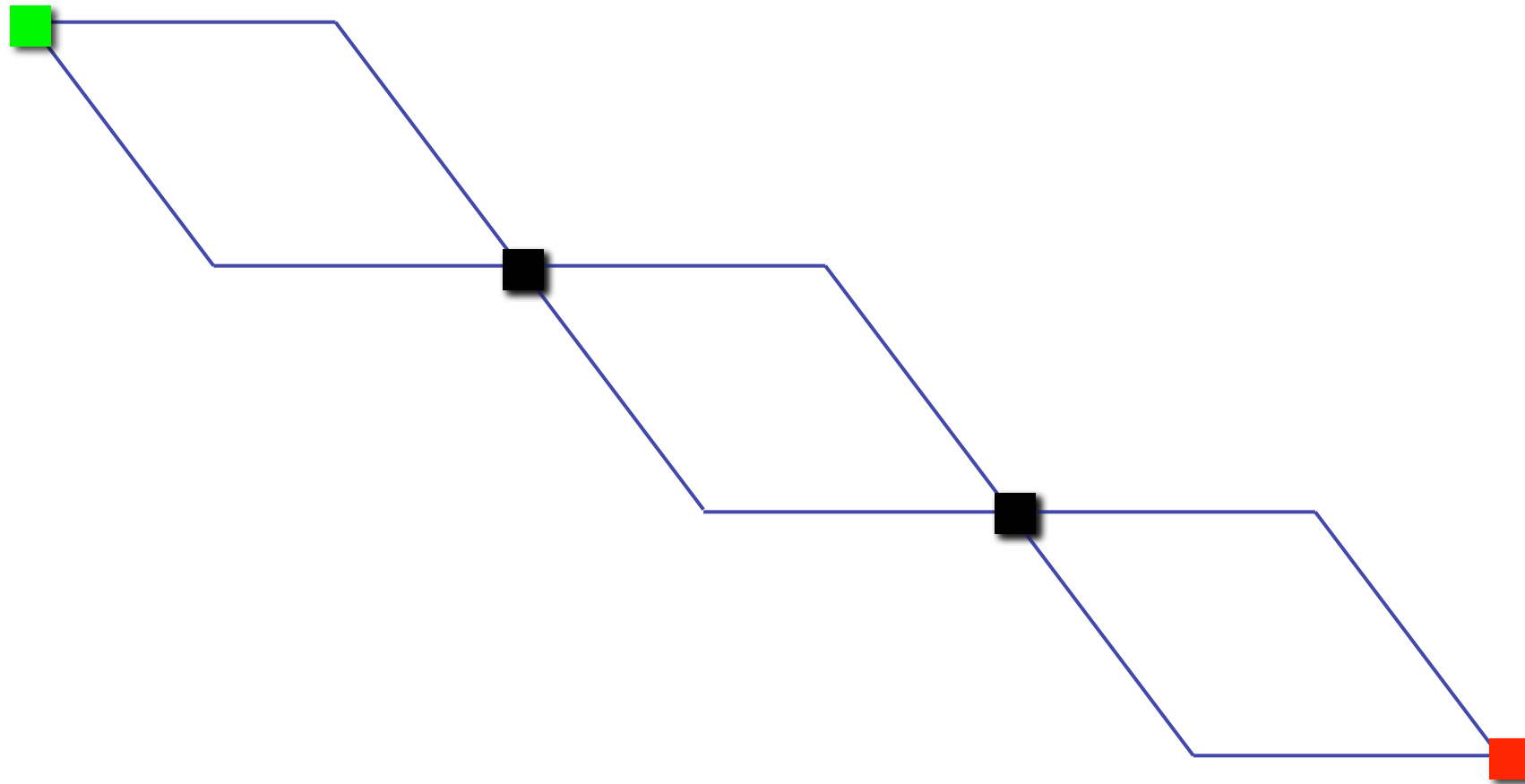
A growing number of routes



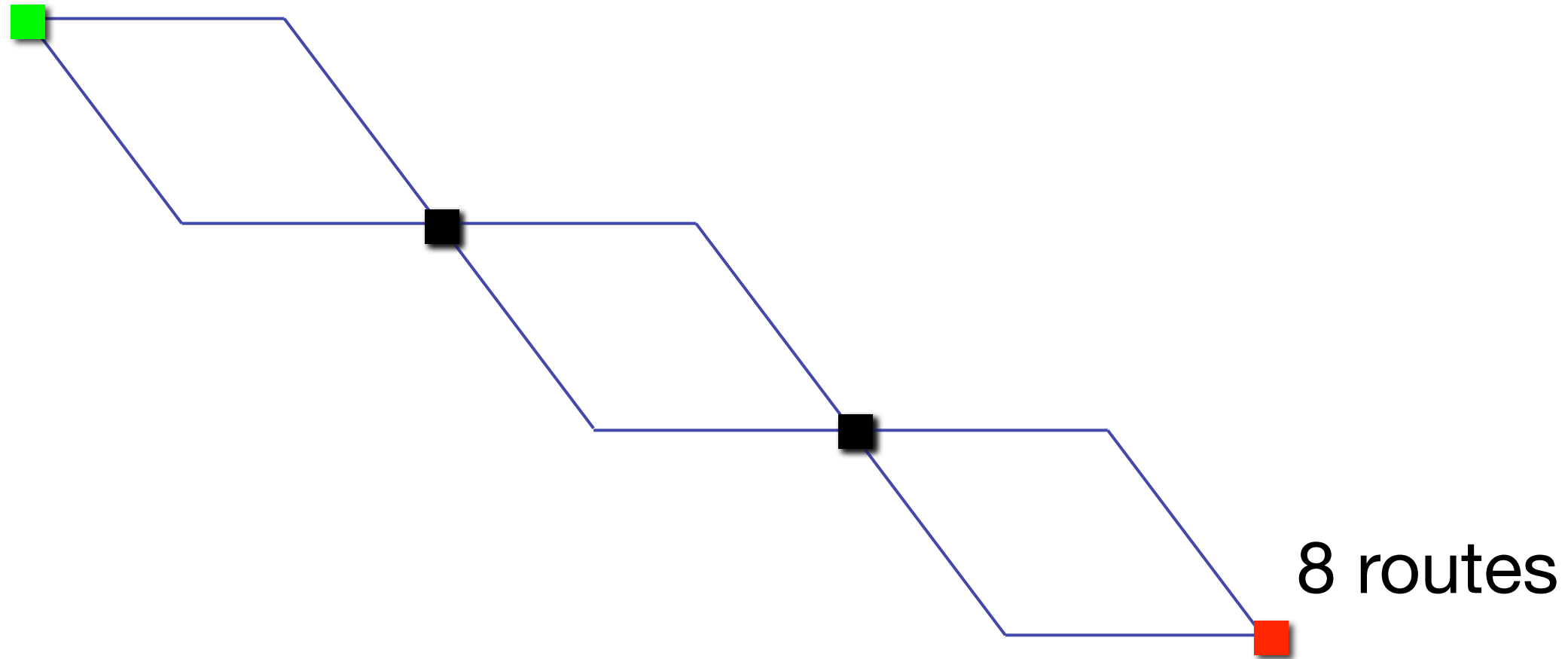
A growing number of routes



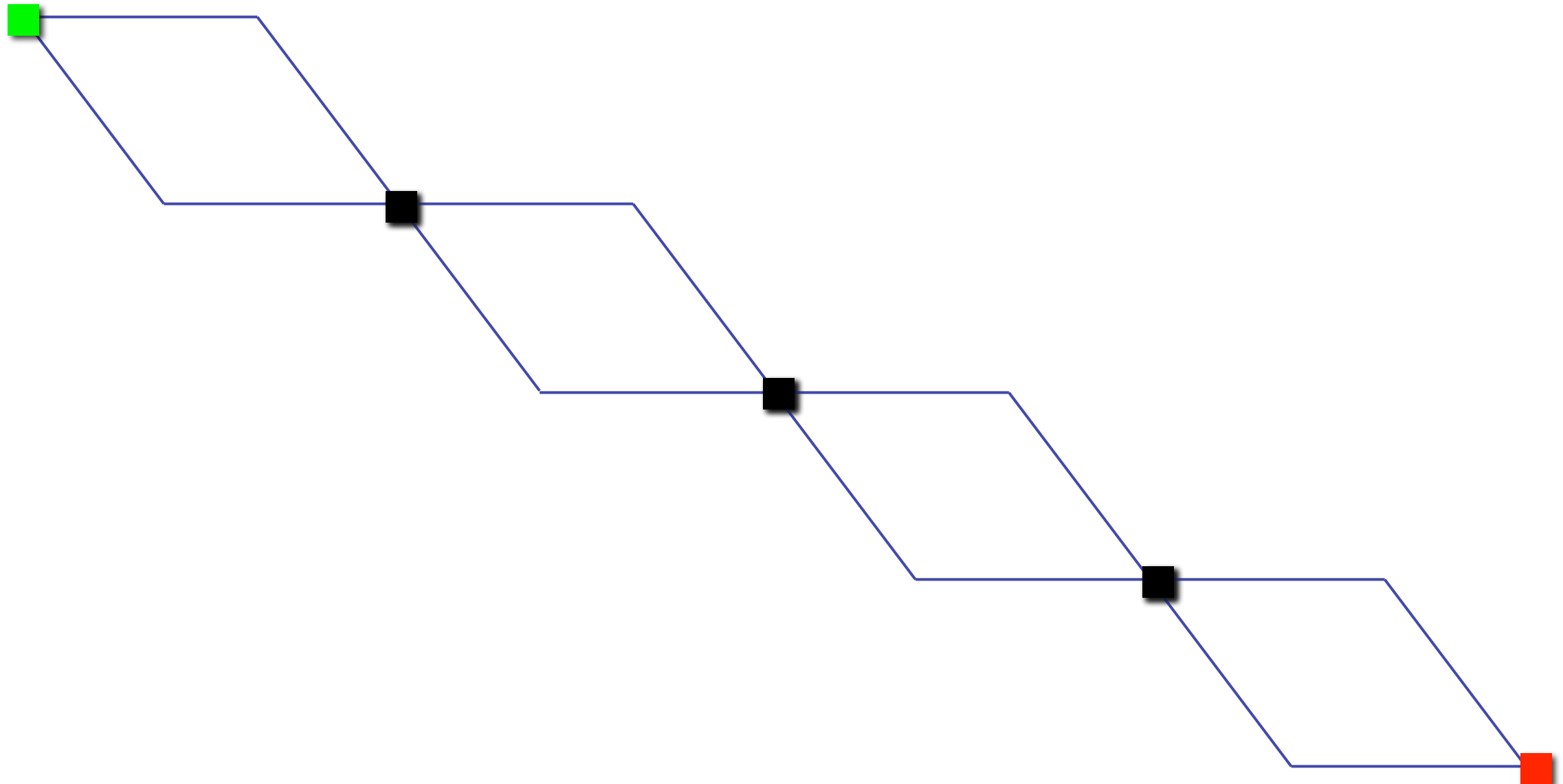
A growing number of routes



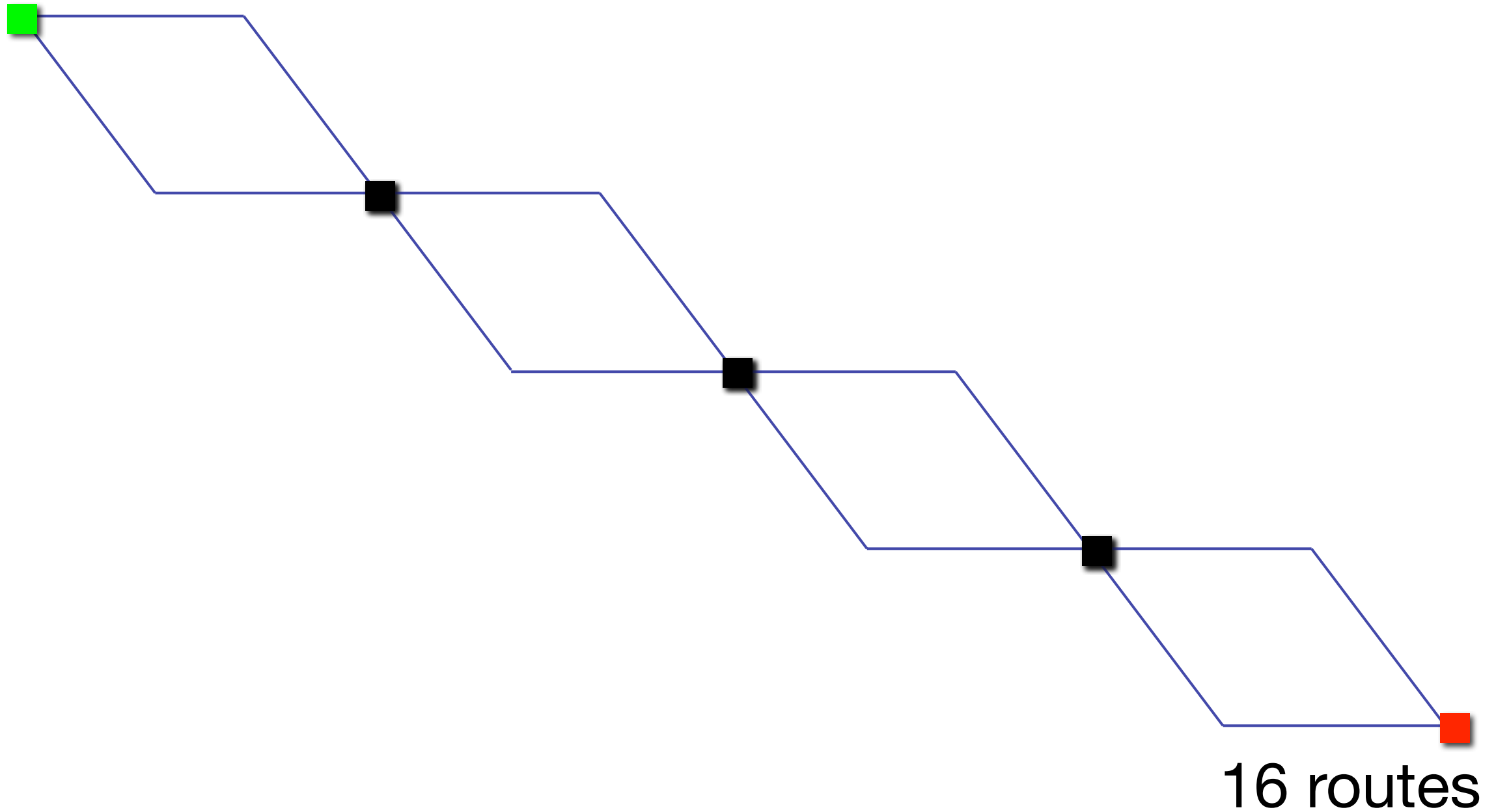
A growing number of routes



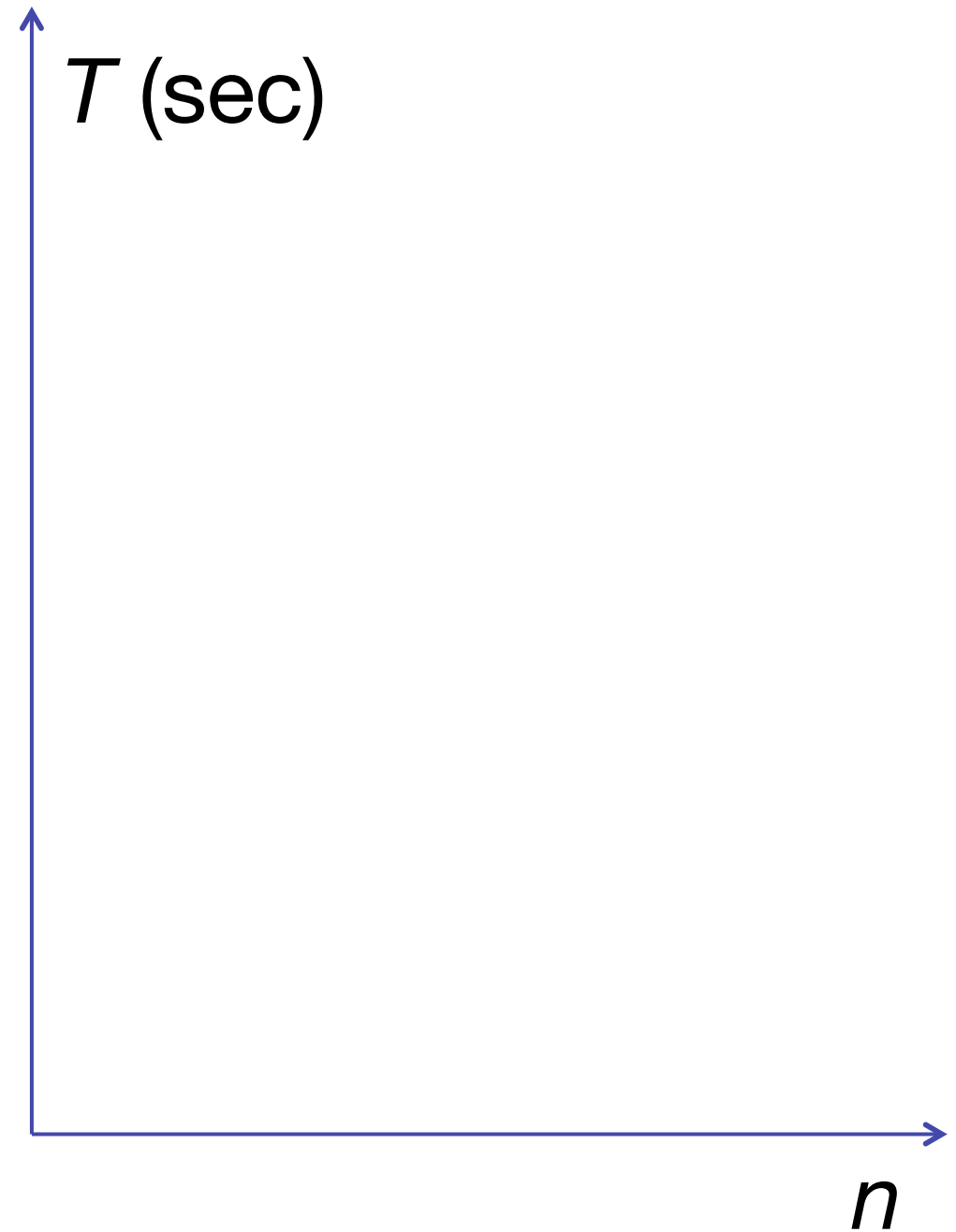
A growing number of routes



A growing number of routes

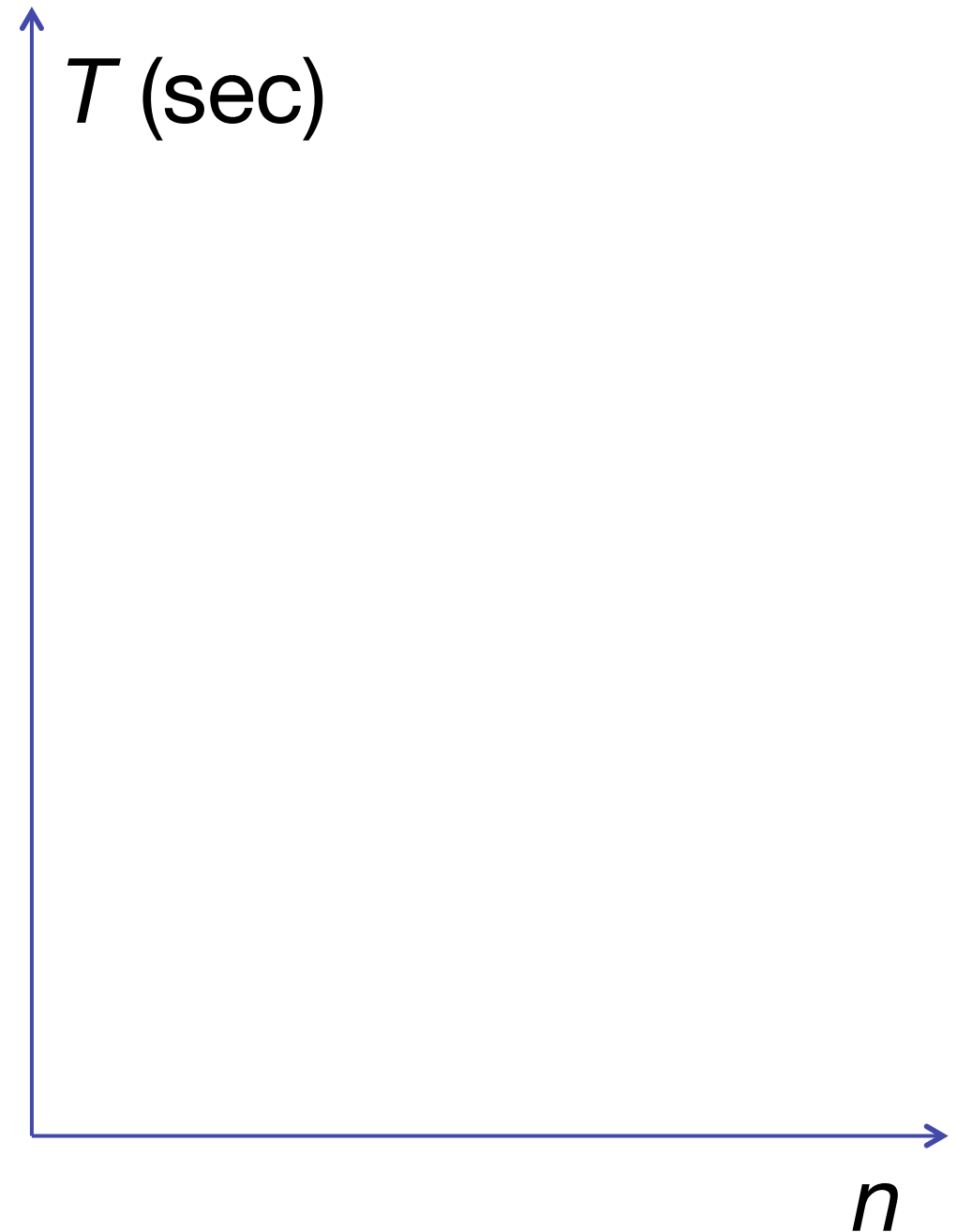


Starts slow and gets slower



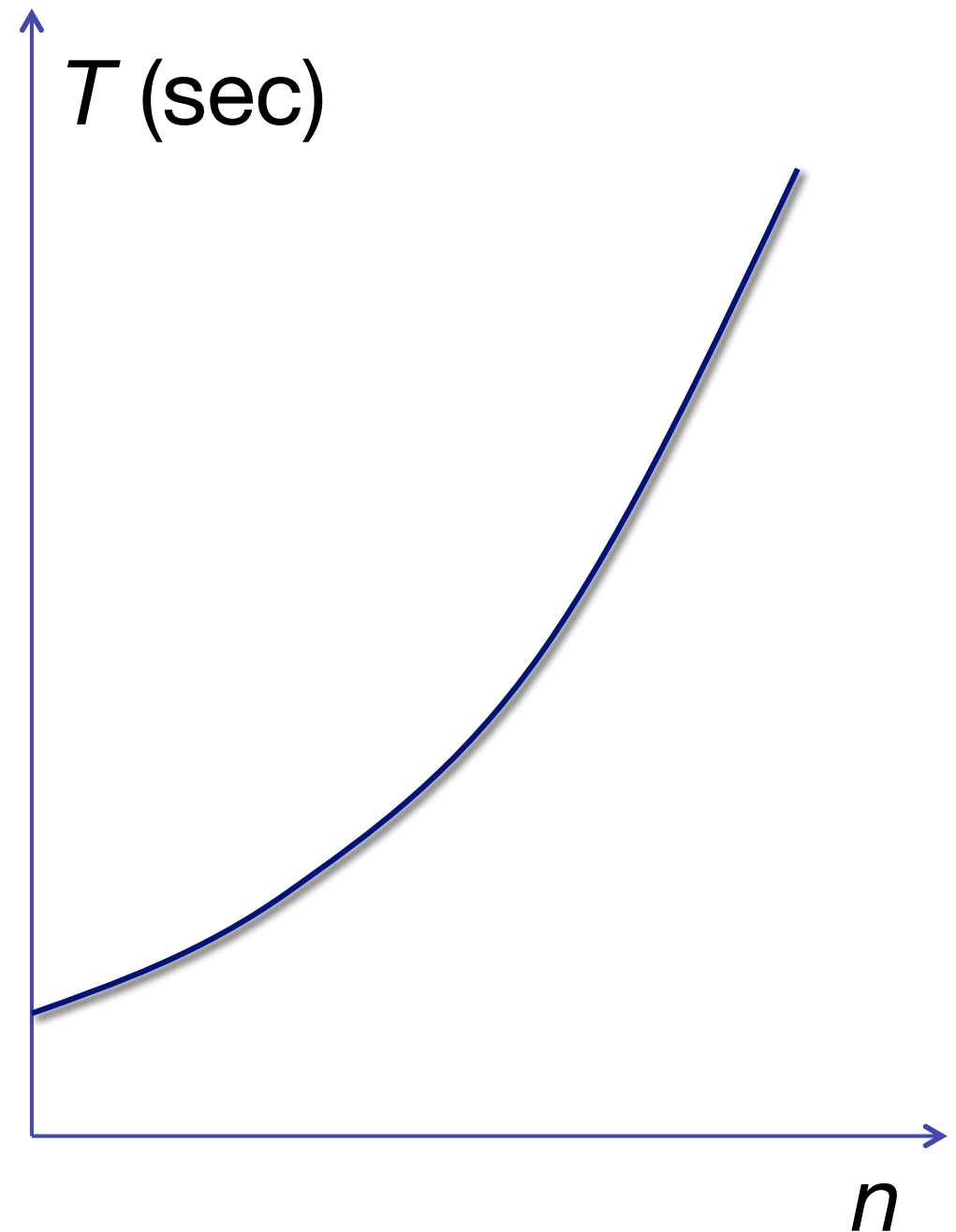
Starts slow and gets slower

The running time is proportional to $2^{n/3}$, where n is the number of towns.



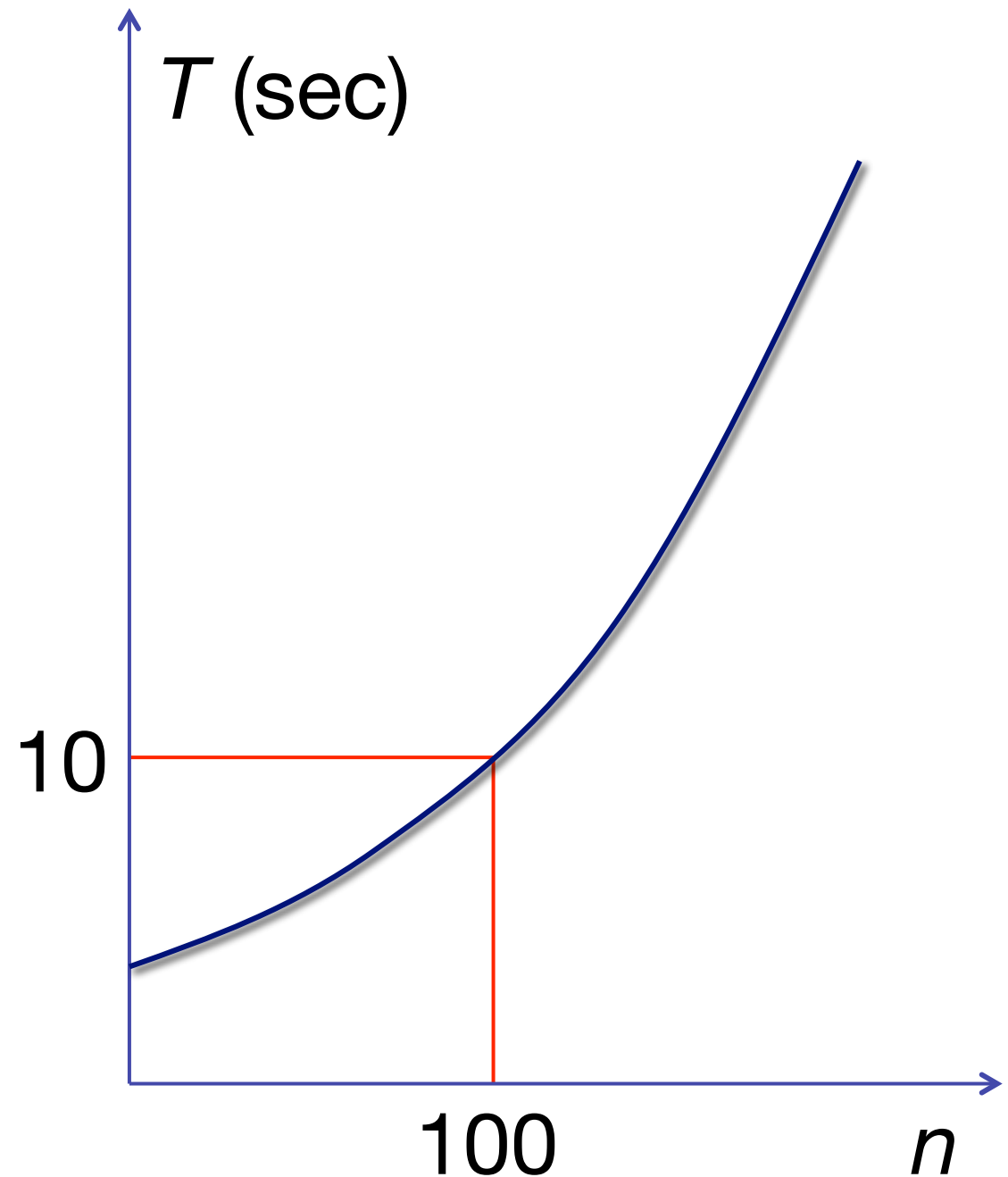
Starts slow and gets slower

The running time is proportional to $2^{n/3}$, where n is the number of towns.



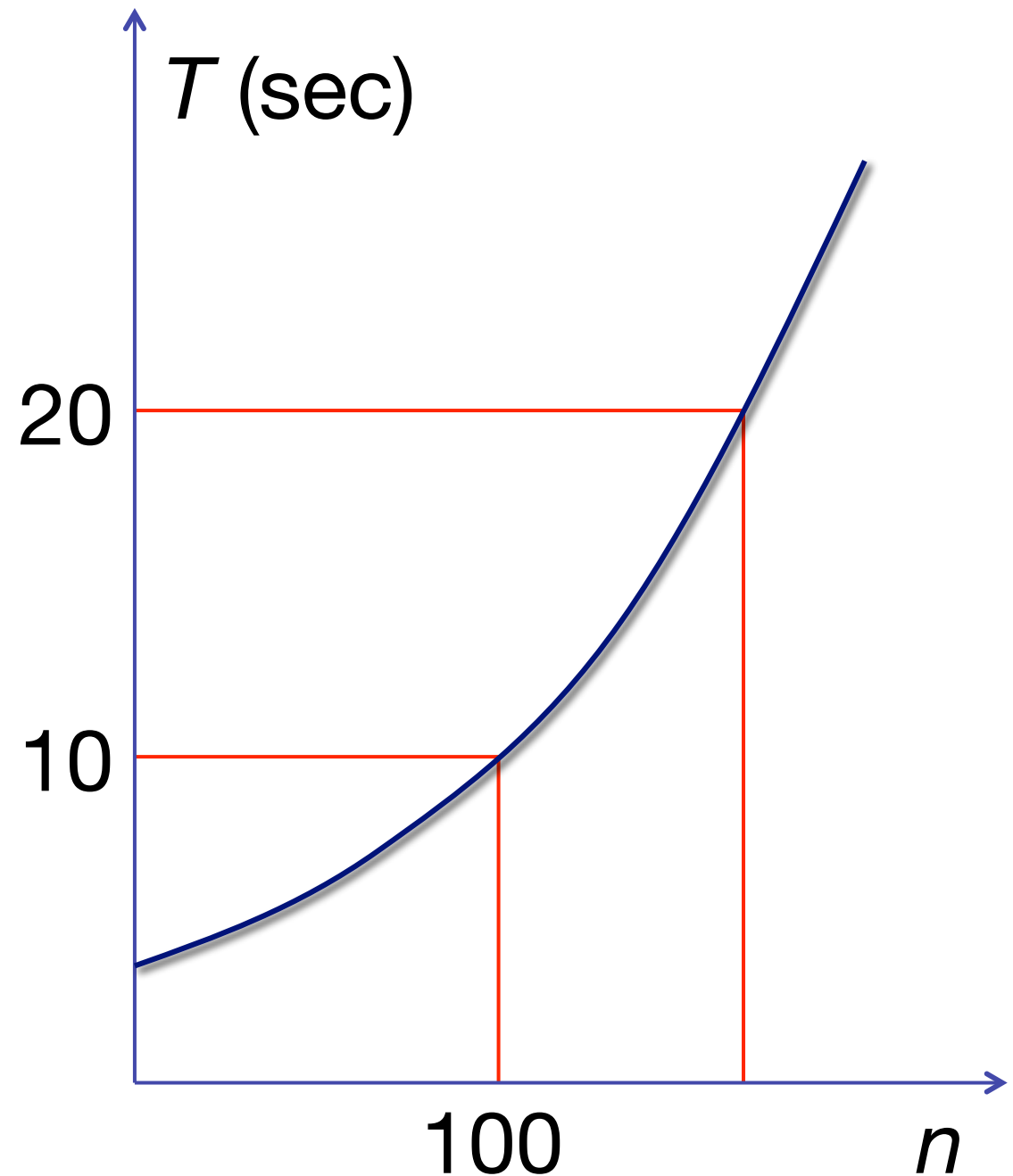
Starts slow and gets slower

The running time is proportional to $2^{n/3}$, where n is the number of towns.



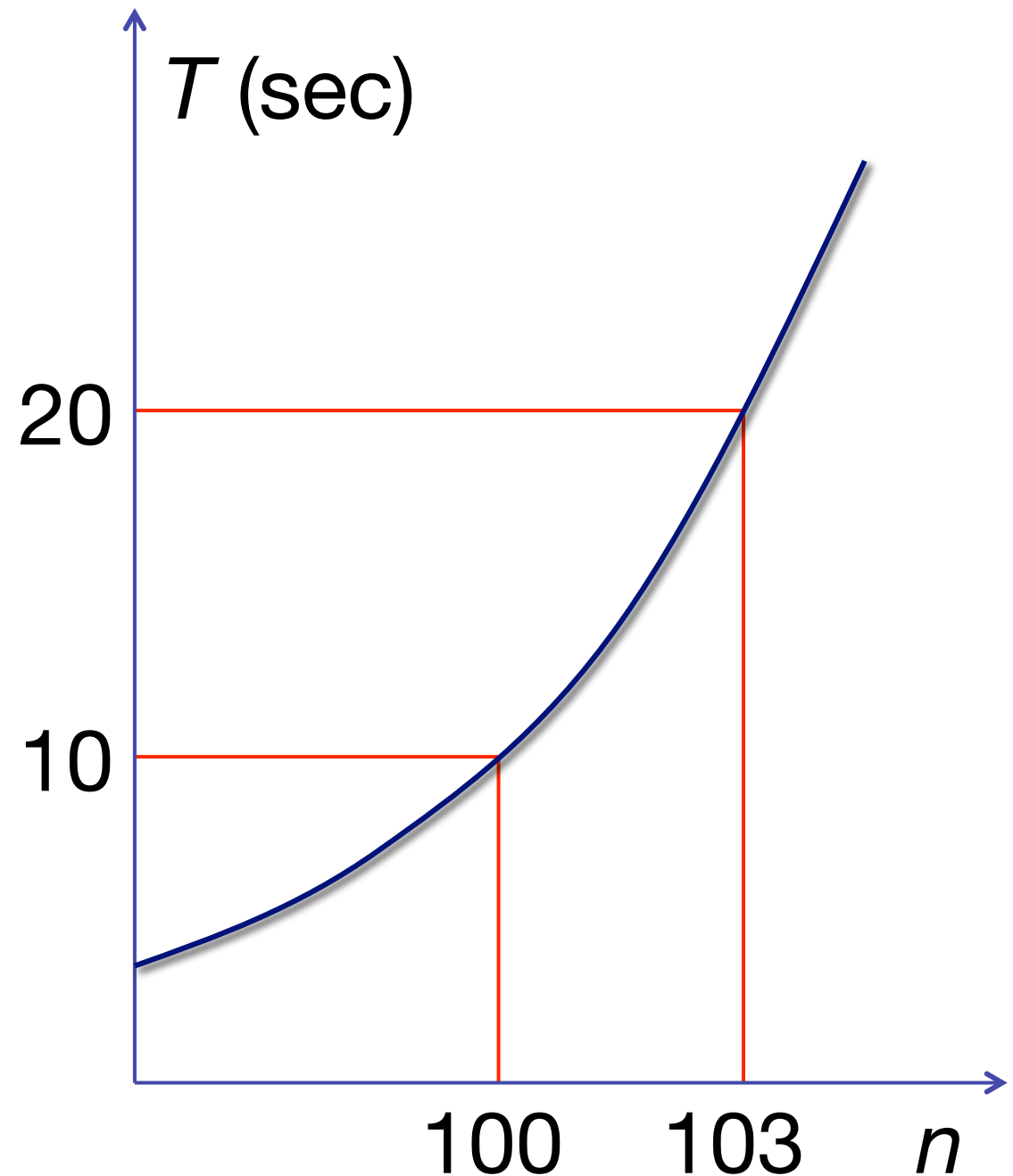
Starts slow and gets slower

The running time is proportional to $2^{n/3}$, where n is the number of towns.



Starts slow and gets slower

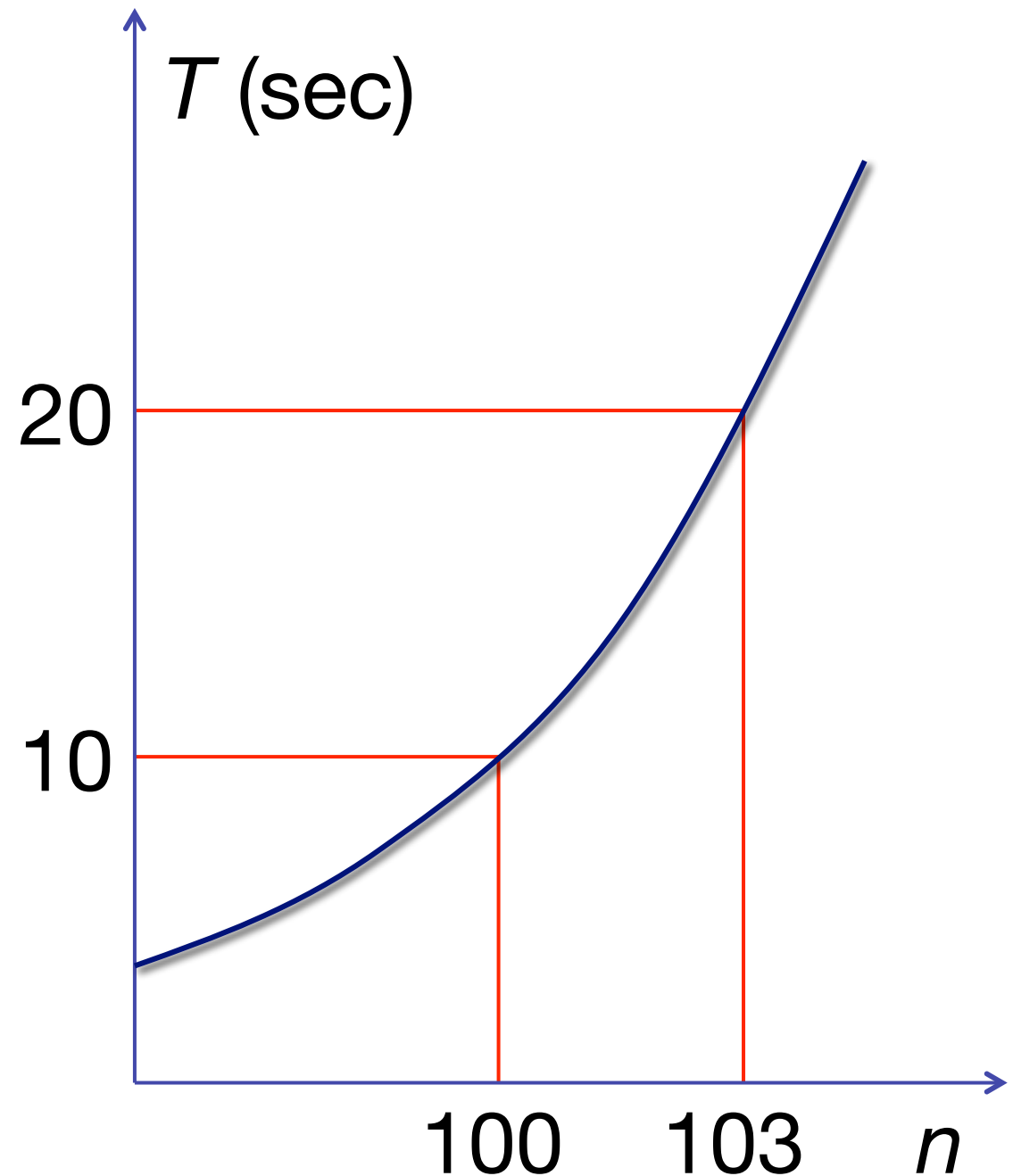
The running time is proportional to $2^{n/3}$, where n is the number of towns.



Starts slow and gets slower

The running time is proportional to $2^{n/3}$, where n is the number of towns.

- adding three more towns will double the time to find a solution.

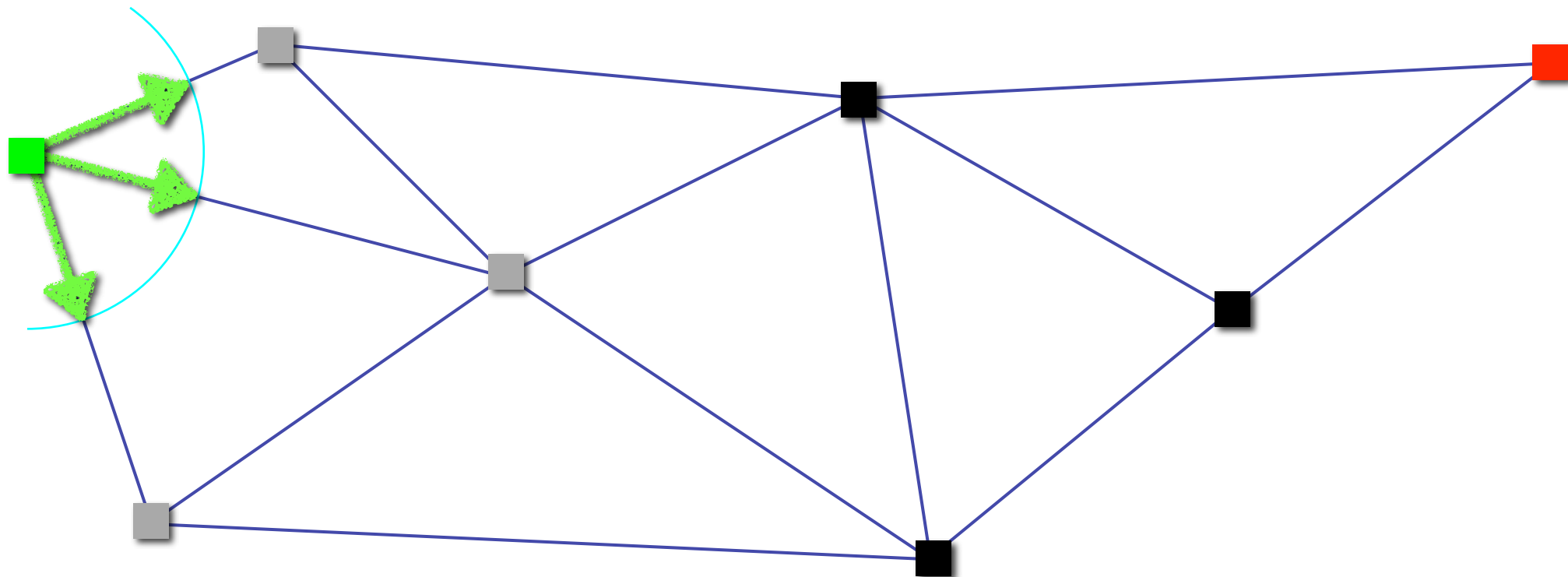


Method C

- Start an army of ants marching on each road out of Manchester.
- Whenever an army captures a new town, send new battalions on each outgoing road.
- The first ants to reach Oxford have gone by the shortest route.

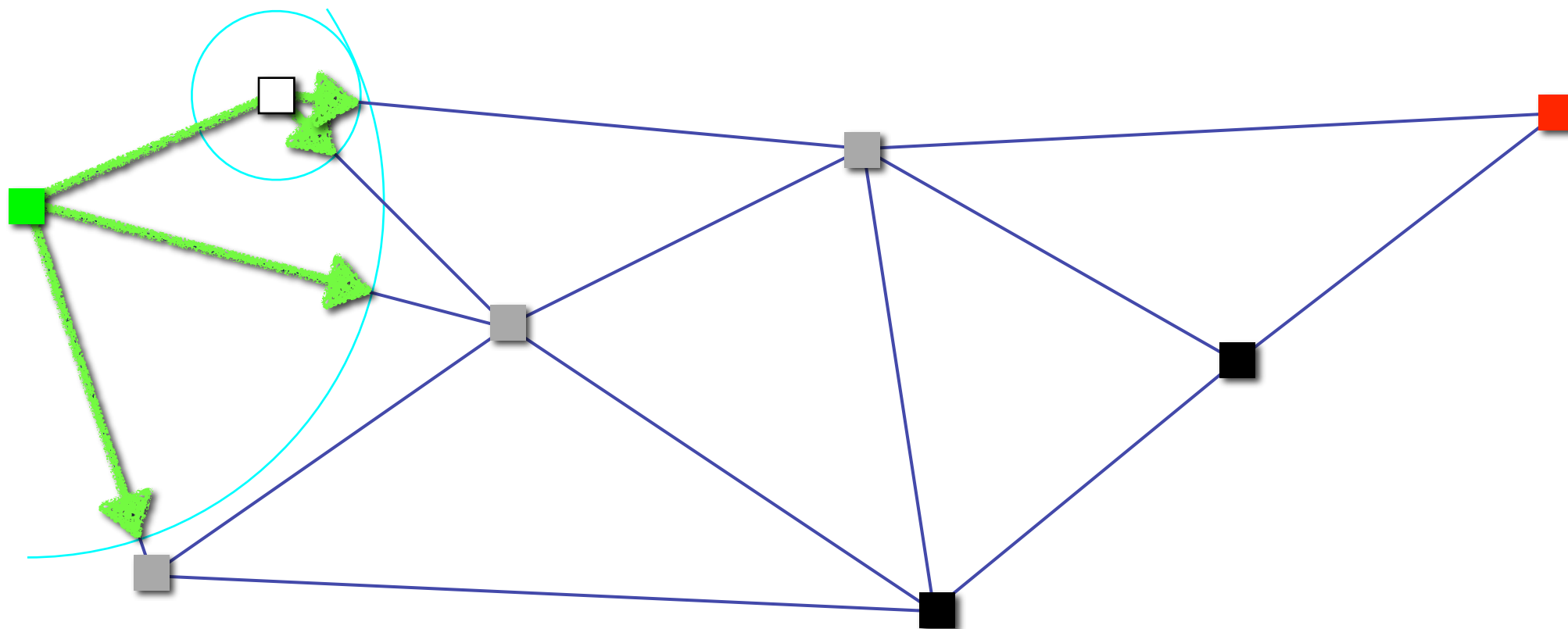
Starting out

The ants start out from Manchester, all going at the same speed.



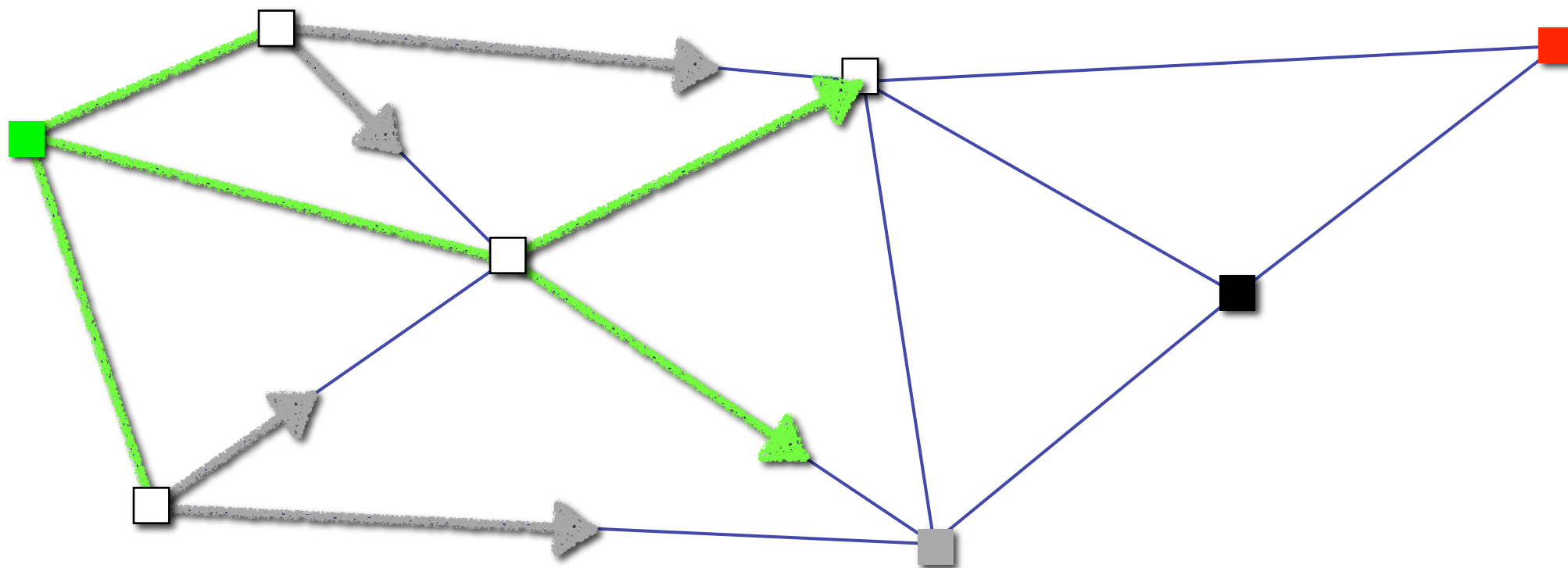
Capturing a town

Each town that is captured becomes a new centre for expansion.



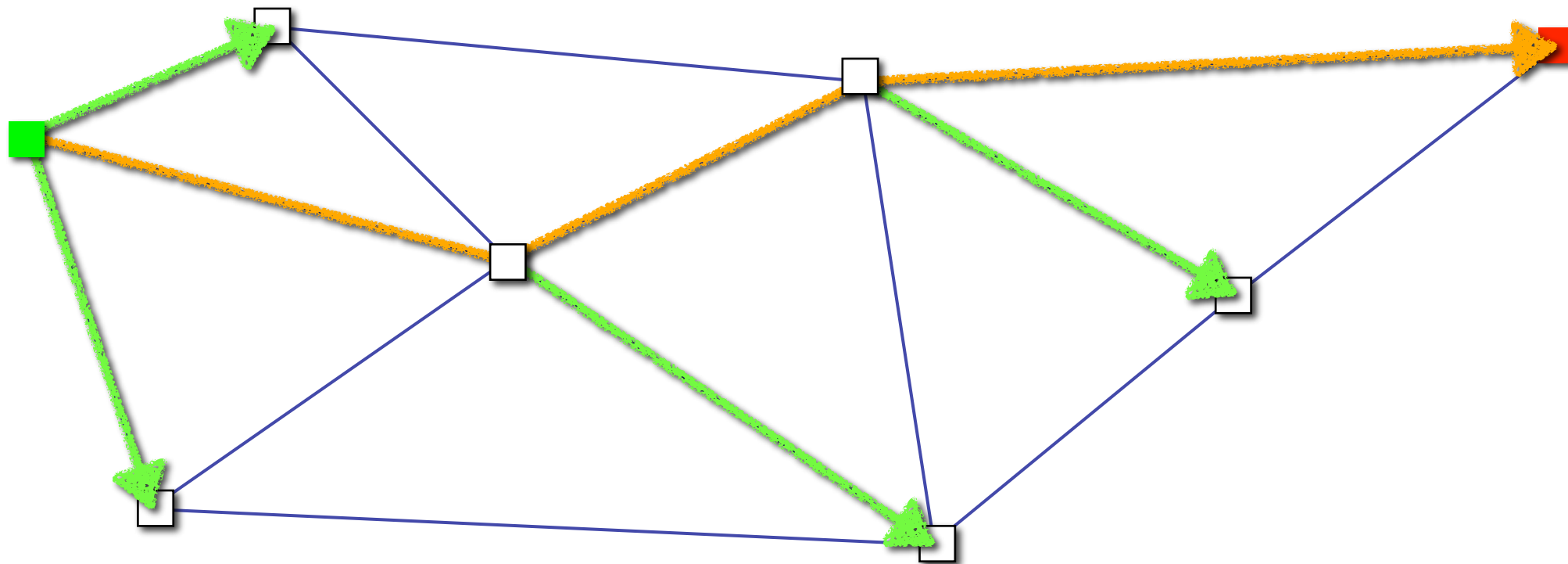
Keeping focussed

An army is disbanded if its goal will already be captured before it arrives.



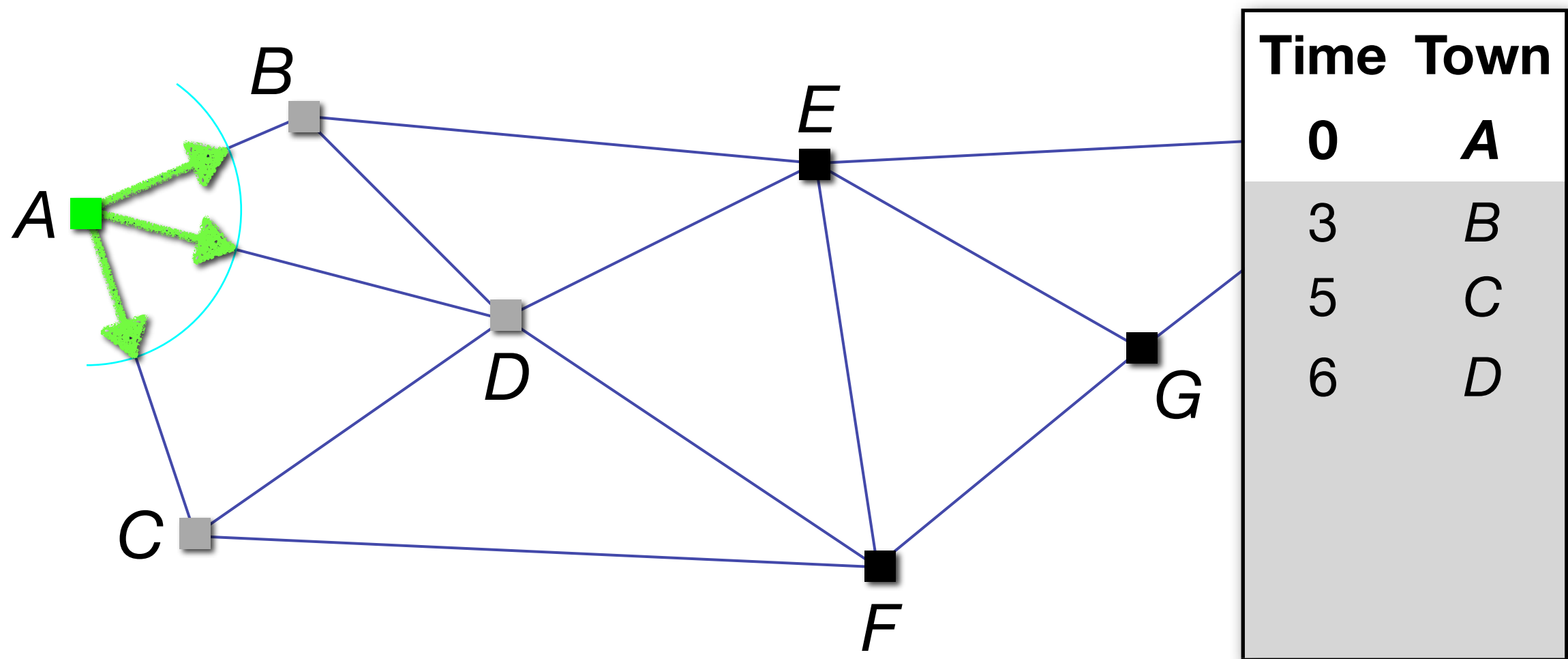
Achieving the goal

When the first army reaches Oxford, we have found the shortest route.



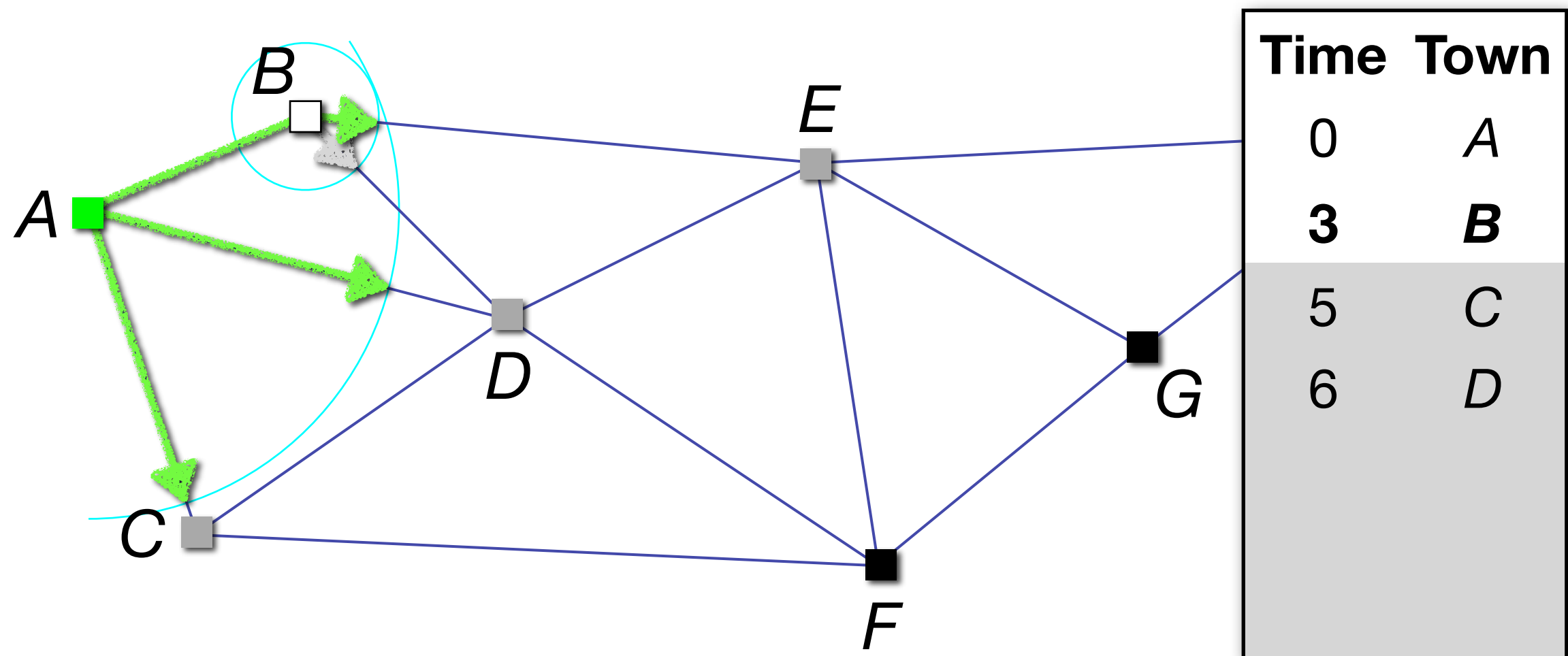
Making it efficient

Instead of tracking the ants step by step, keep an agenda of interesting events



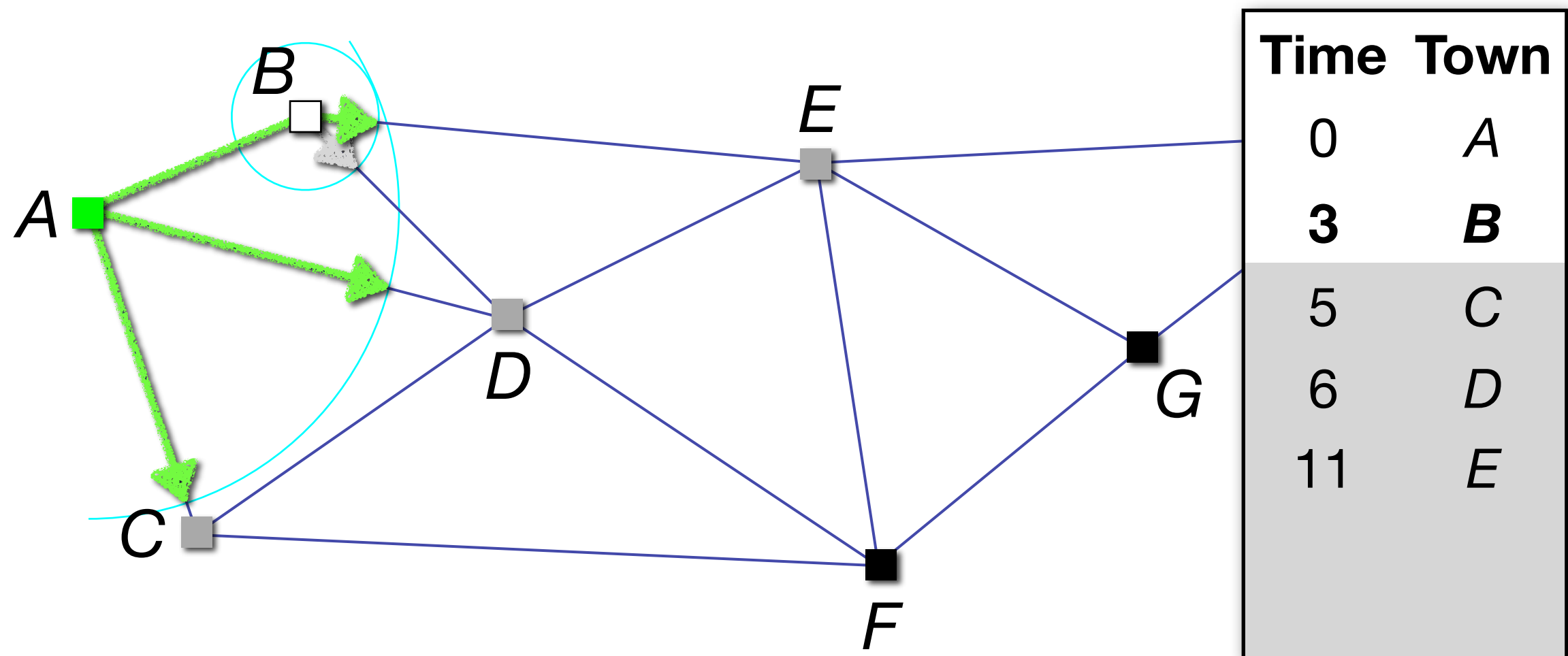
Using the agenda

Advance to the next item on the agenda



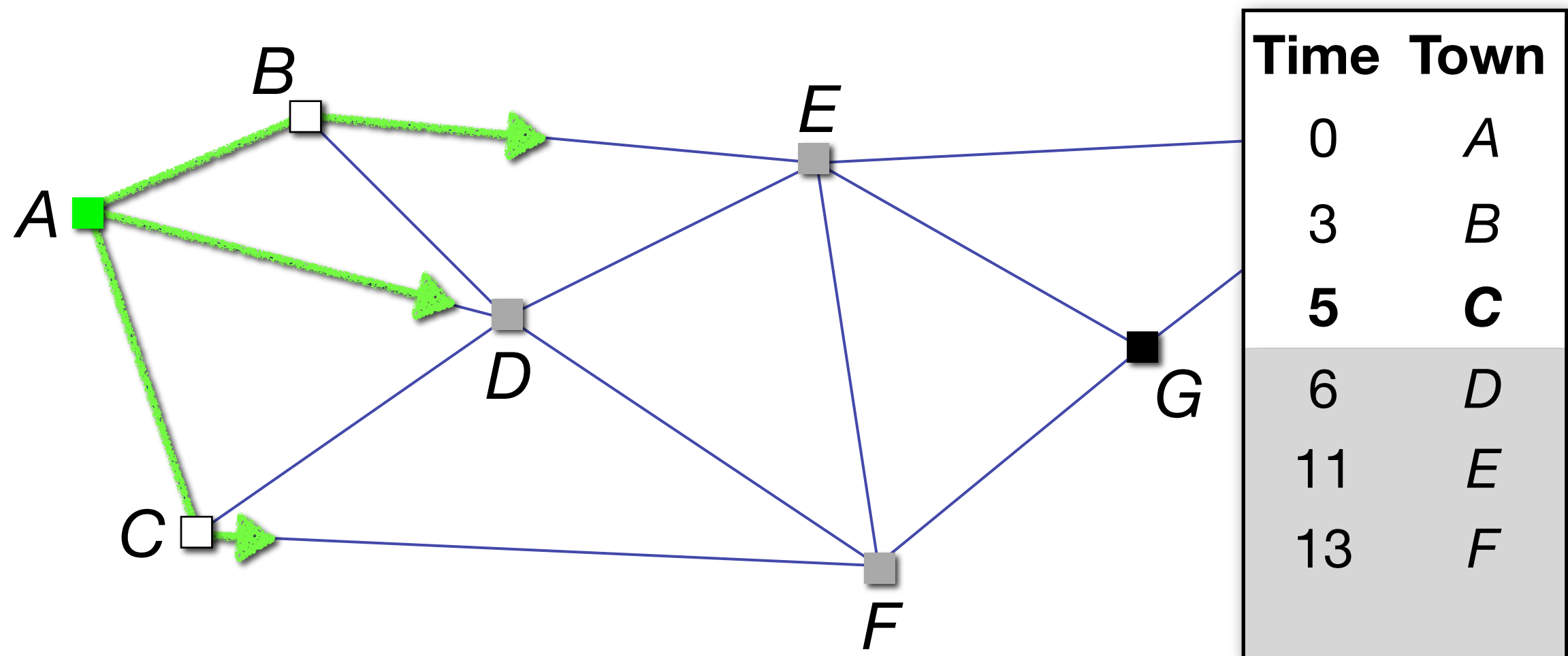
Updating the agenda

Add new items for the outgoing armies



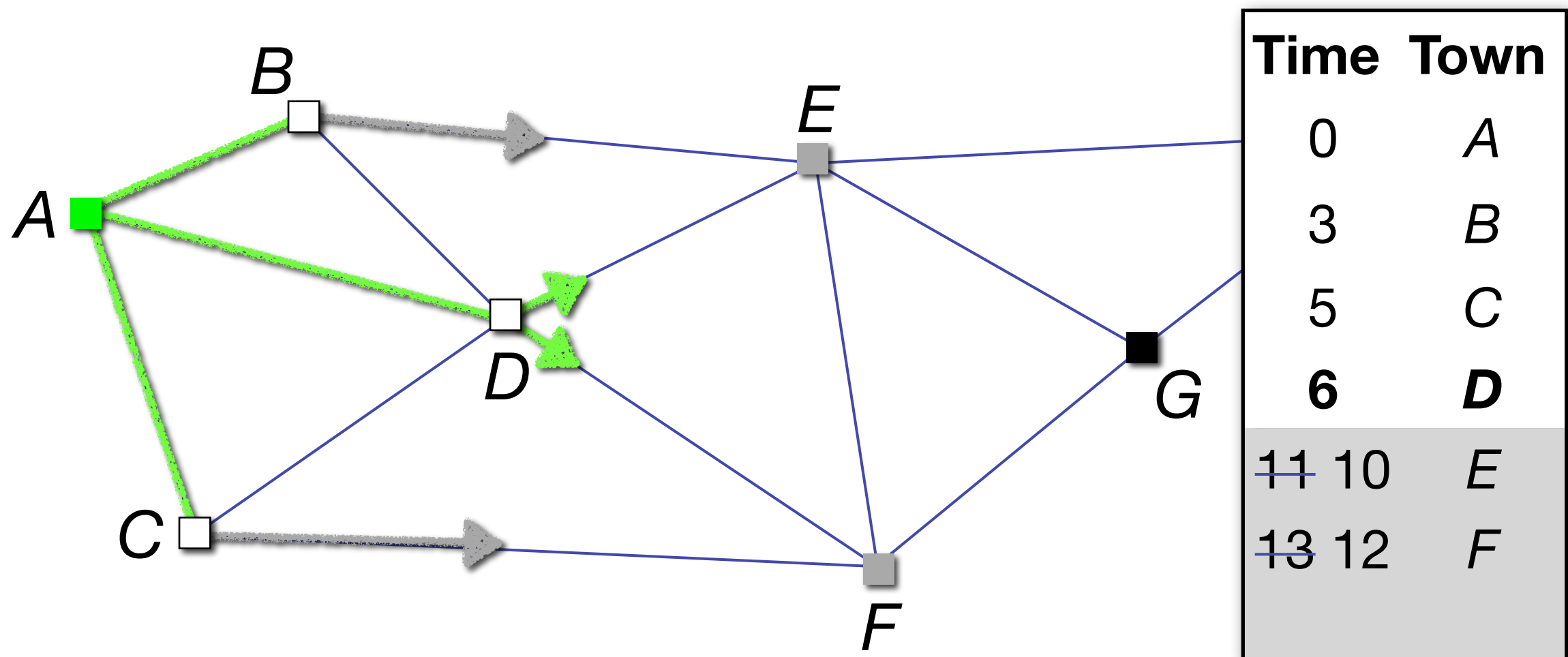
Carrying on

Keep advancing to the next item



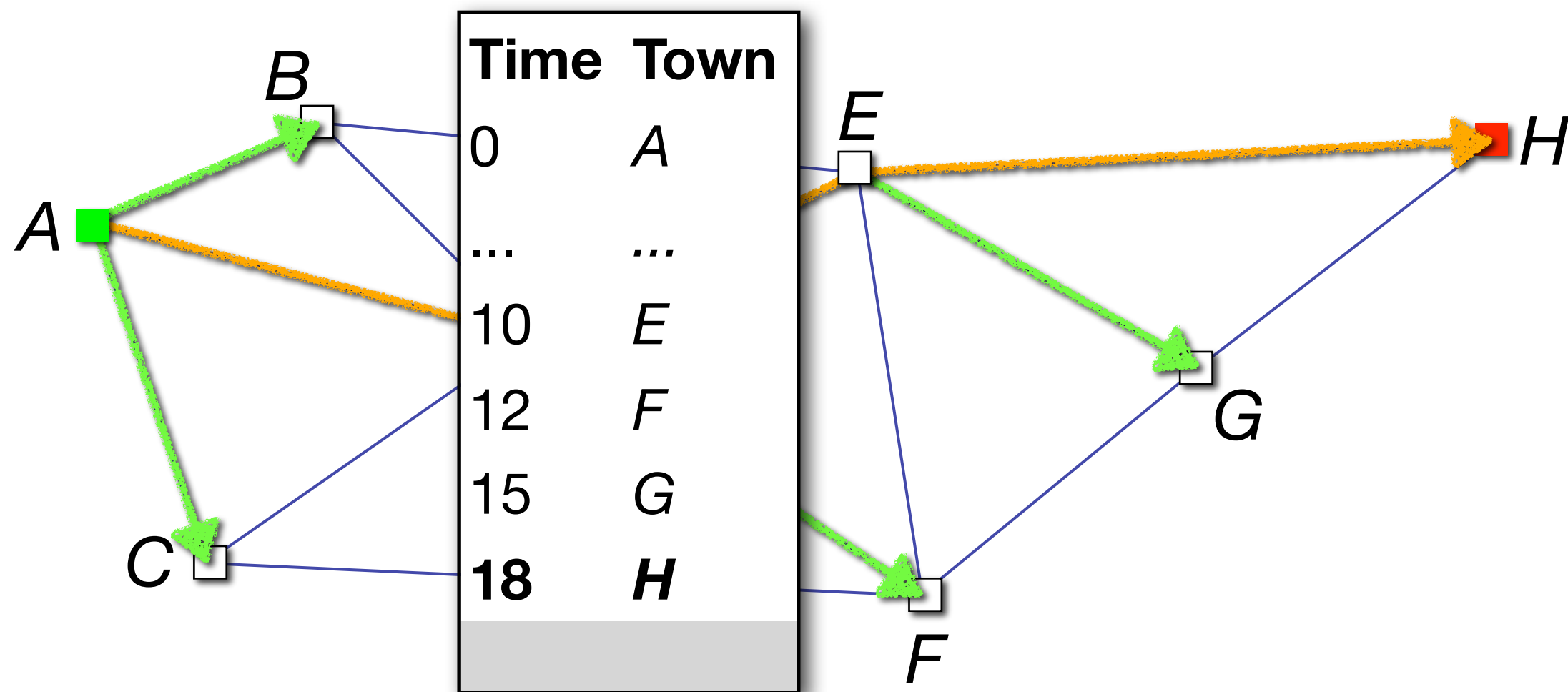
Overtaking

Sometimes one army can overtake another



Reaching the goal

When the destination town comes to the top the agenda, the shortest path is known



Why the method is useful

Method C (Dijkstra's algorithm)

- Always gives the right answer.
- Does so in a predictable time.
- The time taken grows only gradually as the map gets bigger.

[Demo]

Writing it as a program

Writing it as a program

```
while (dst.colour != WHITE) {  
    t = ChooseMin();  
    t.colour = WHITE;  
    UpdateEstimates(t);  
}
```

Java



Writing it as a program

```
while (dst.colour != WHITE) {  
    t = ChooseMin();  
    t.colour = WHITE;  
    UpdateEstimates(t);  
}
```

Java

```
while dst.colour  $\neq$  white do  
    t := ChooseMin( );  
    t.colour := white;  
    UpdateEstimates(t)  
end
```

Oberon Pascal



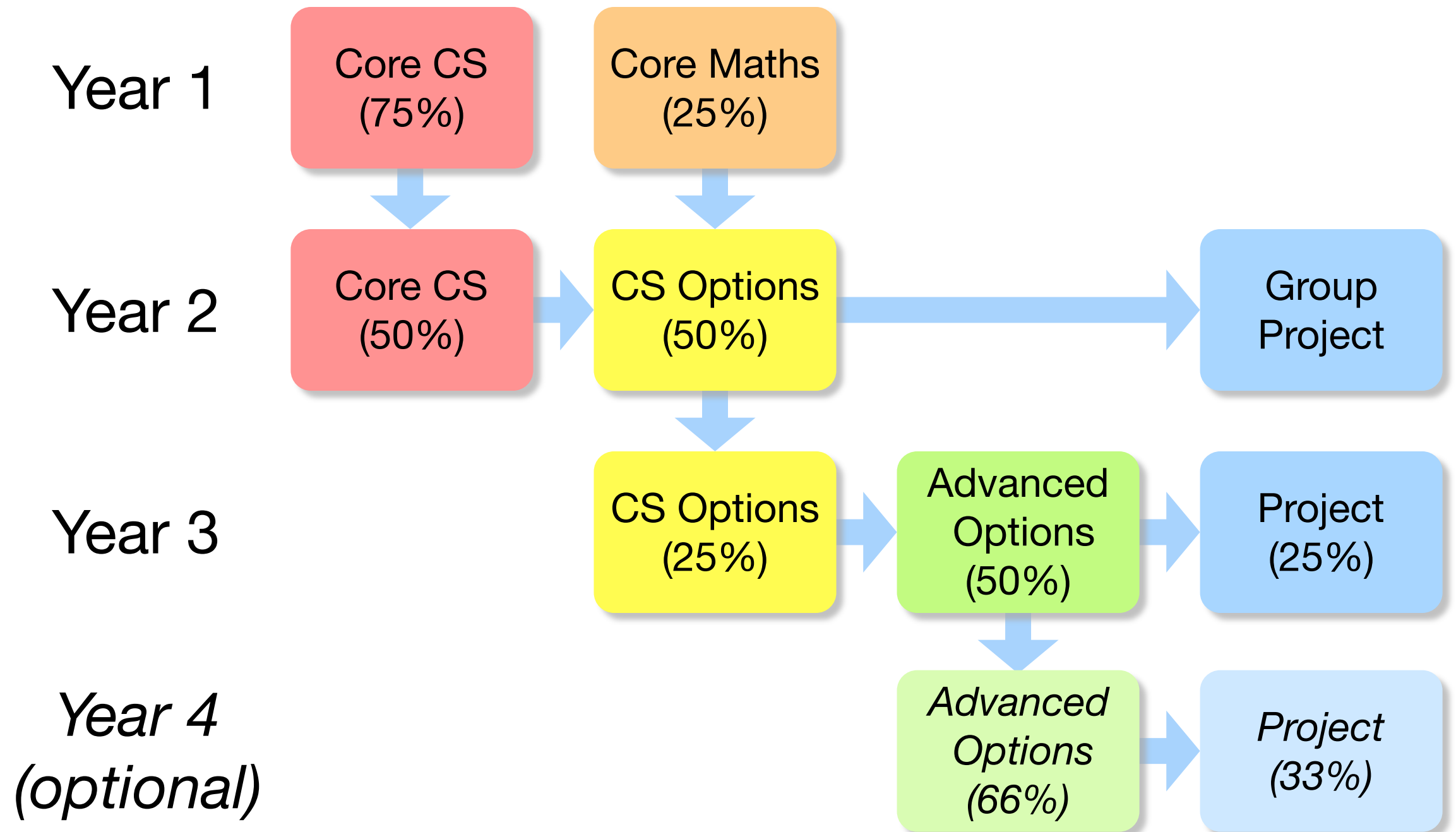
Computer Science

- It's *not* about learning new programming languages.
- It *is* about understanding why programs work, and how to design them.

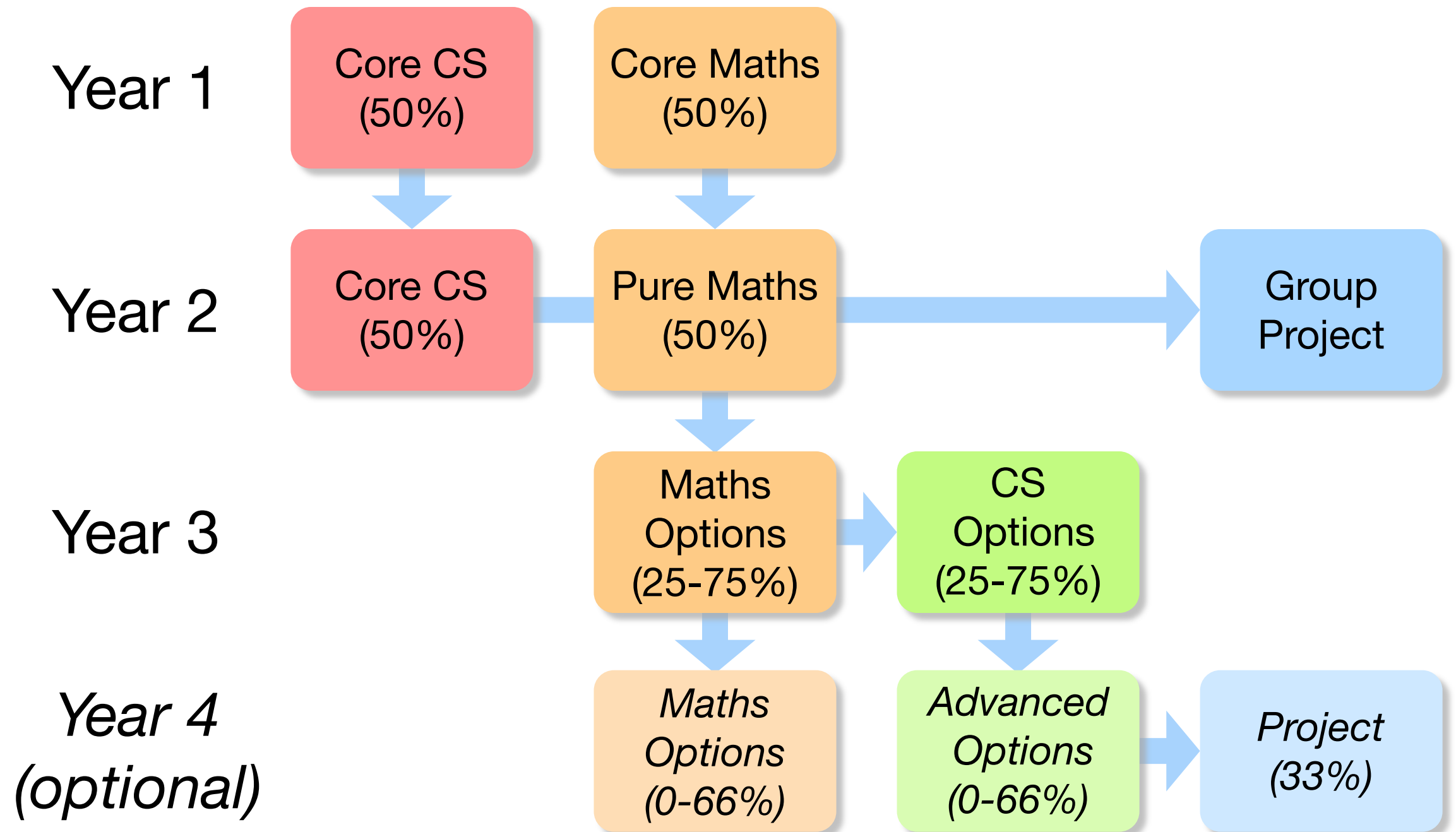
Computer Science at Oxford

- What's Computer Science about?
- The Oxford courses

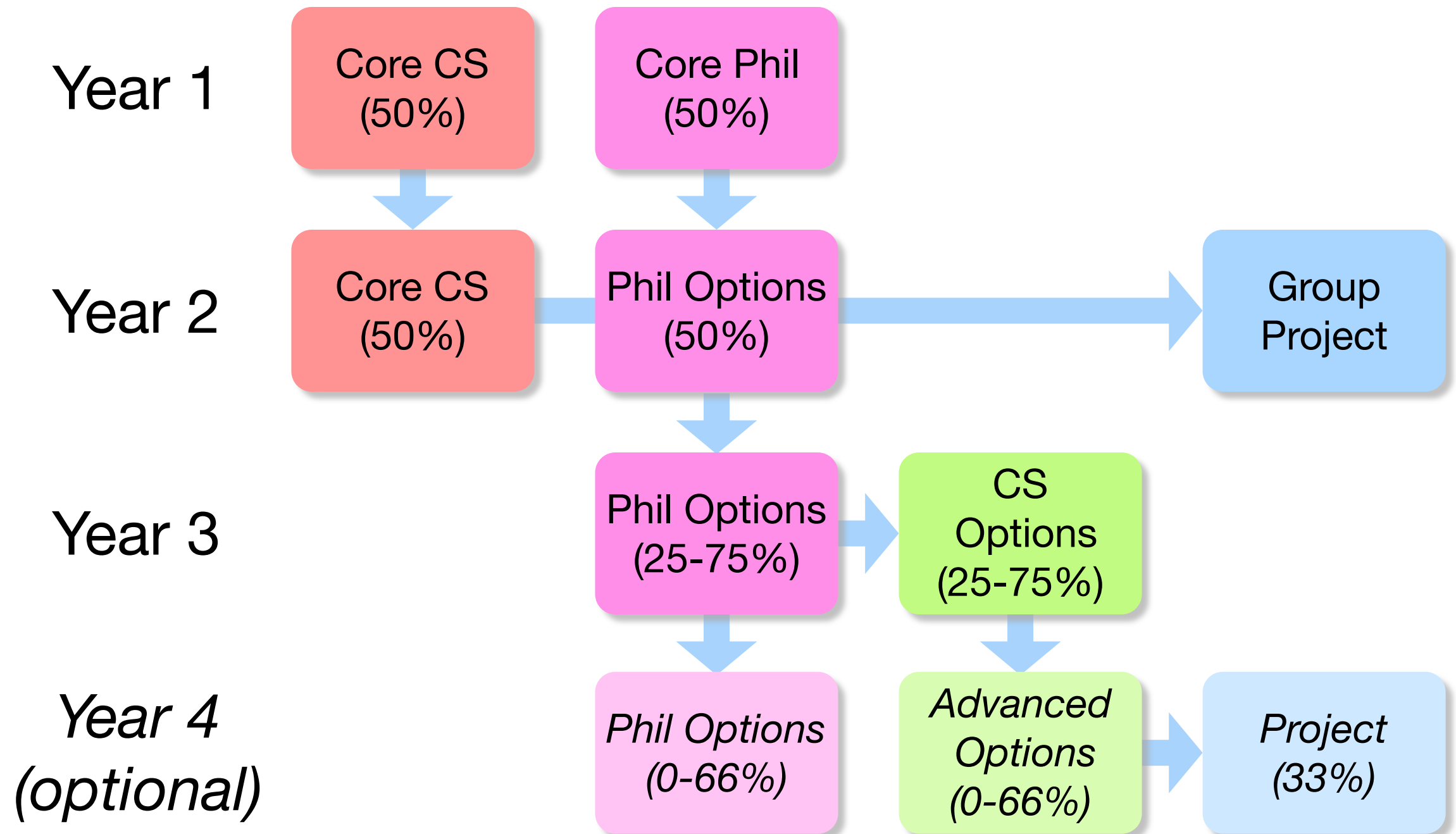
Computer Science



Maths & Computer Science



Computer Science & Philosophy



Why CS at Oxford?

- Computer Science from the start.

You study just Computer Science from day one, and we assume no prior knowledge.

- Principles behind the technology.

You will learn the latest technology, but you will learn lasting principles as well.

- Personally-tailored tuition.

Like all Oxford degrees, our teaching revolves around paired or one-to-one tutorials.

Why Oxford?

Academic

- A rigorous approach
- Able and keen fellow students
- Teaching from world experts

Social

- Rooms, books, meals
- Sport, politics, music, drama
- Making friends for life

Career

- Boundless opportunities await